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APPARATUS FOR THE MANUFACTURE OF GLUCOSE.

WITHIN the last few years, extensive works have been started for the preparation of glucose from amylaceous substances extracted from corn and rice, the starch of which is substituted for that of the potato in such manufacture.

From whatever it be derived, the starch is converted into dextrine and then into glucose by the action of diluted sulphuric acid. Such saccharification is effected in apparatus of various kinds.

Messrs. Warein & Defrance have just devised a type of such apparatus which possesses great advantages over its predecessors, both as regards the ease with which it may be used and the efficiency of the work. Instead of previously prepared starch being treated, the whole grain is introduced into the apparatus, which performs at once a double operation, and this is why it is called a boiler and saccharifier. The apparatus consists of a cylindrical receptacle supported by four legs and traversed longitudinally by the shaft of a stirrer provided with multiple paddles. This is actuated during the boiling by an independent set of belts and gearings.

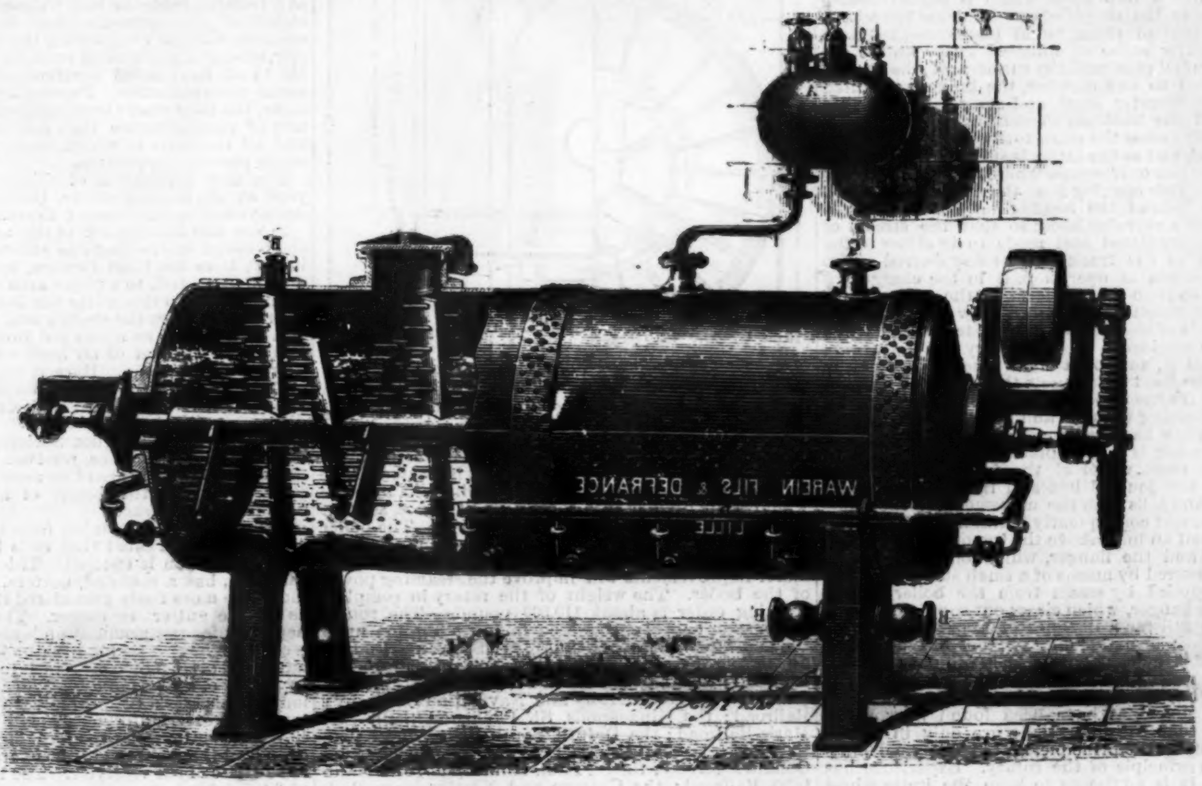
The water is introduced through the conduit, C, and the grain through a wide tubulure whose cover is provided with a tight joint.

Around the cylinder, and at a short distance from it, runs a pipe provided with fourteen branches connecting it with the boiler. The steam admitted at D is thus distributed uniformly through the mass of water and grain, which is submitted to a pressure of three kilogrammes.

As soon as the boiling is sufficiently advanced to have converted the mixture into starch, the sulphuric or hydrochloric acid is slowly introduced into the metallic receiver, A, through the pressure of steam from the generator. At the end of fifteen or twenty minutes the saccharification is complete.

The mixed aerial vapors given off at the beginning of the operation escape to the exterior through the pipe, B', while at B and B' there are conduits for drawing off the liquid and the residua of the manufacture.

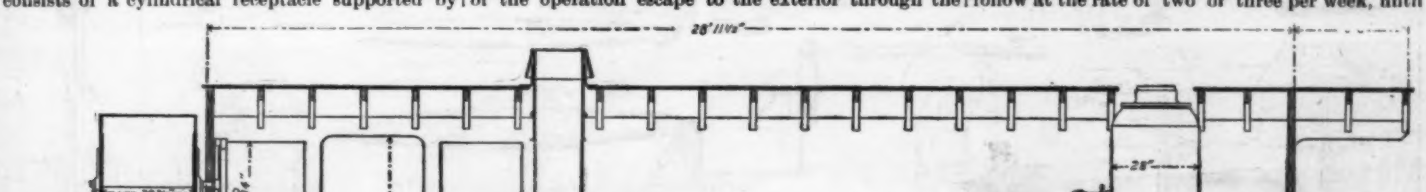
This apparatus, the arrangements of which have recently been patented, not only shortens the period of the operation, but is so constructed as to endure the action of the acid without injury. Besides, its yield is greater, with less consumption of fuel, than in the ordinary saccharifying apparatus.—*Revue Industrielle.*



APPARATUS FOR THE MANUFACTURE OF GLUCOSE.

THE LESLIE ROTARY STEAM SNOW SHOVEL.

THE accompanying illustration in outline represents the latest form of the rotary now under construction at the Cooke Locomotive Works, of Paterson, N. J., for the approaching season. We give elsewhere other engravings showing the working of the earlier machi[illegible]nd also the old style of track clearing. [illegible]en of these new rotary shovels are now buildin[illegible]ting three for narrow gauge roads, several of wh[illegible]ve already been shipped, and the others will follow at the rate of two or three per week, until the

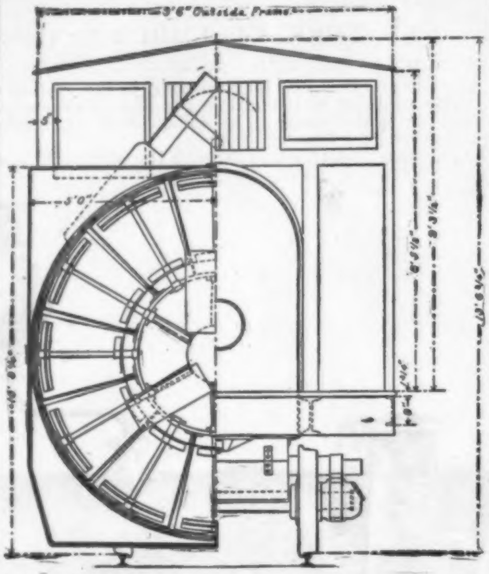


THE LESLIE ROTARY STEAM SNOW SHOVEL.

last machine for this year's service has left the works. Several alterations and improvements have been produced this year, but the general principle of the rotary remains unaltered, as shown in previous illustrations. The general construction of the rotary is well known to the majority of our readers, but a brief description may be useful.

A stout frame of heavy I-beams is mounted upon two four-wheeled diamond trucks, the whole construction being of extra strength. This frame carries a large locomotive pipe boiler, with a firebox which extends the full width between the wheels, as shown in the rear elevation. This boiler supplies steam to two 17×22 cylinders with Walshehart valve motion. Each cylinder works a short shaft, on which is fast a bevel wheel 33 inches in diameter in pitch line. These bevel wheels gear into a larger bevel wheel, 49⅝ inches in diameter on pitch line, fast on the main shaft, driving the knife wheel placed in the front of the machine. This wheel is 10 feet in diameter and is set in a round casing, with a flaring, square front 10 feet wide and the same height, which is made of half-inch steel plate. This casing serves to cut the bank vertical on each side, by its corner gussets; the snow which the wheel cannot reach is carried to the knife wheel. The rotary wheel contains a hub upon which is placed twelve radial plates, in the shape of an immense fan wheel. Upon the front of these radial plates are placed an inner and outer series of knives. These knives are pivoted on radial pins, and the surfaces of the knives being inclined to one another, the knives are canted when they encounter snow, and are set so as to slice the snow off the bank on to the fan, the centrifugal force of which causes the snow to fly to the outside of the fan wheel, and as the latter is surrounded by a casing, the snow can only escape where an opening is provided for it. This opening is at the top of the wheel, immediately behind the headlight. The opening is provided with a movable hood, so that the stream of snow can be regulated and made to fly either to the right or left of the track, and at any desired angle. The rotary, when in operation, is in the charge of a pilot, who stands on the platform in the front end of the cab, from which he has a full view ahead, as well as on each side of the track. By a system of signals he controls the engineers on the rotary and locomotive which pushes it, and by a hand wheel can alter the position of the hood that directs the stream of snow to either side. He has also charge of the ice breaker and flanger for cleaning the rails and flanges after the main body of the snow has been removed by the rotary.

The ice breaker is a stout plate of steel, hanging in front of the front wheel of the front truck, and so attached to the journal box and frame of the truck that it rises and falls with the movement of the front truck wheels, and consequently maintains a fixed position about half an inch above the top of the rail. The ice breaker and the flanger, which follows it, can be raised and lowered by means of a small steam cylinder, which is supplied by steam from the boiler of the rotary. The flanger, which clears out snow from both sides of the rail for a distance of about 12 inches, is attached in a somewhat similar manner in rear of the rear wheel of the front truck. Any ordinary locomotive tender can be attached to the rotary for the purpose of carrying water and coal for the supply of its boiler. The machines have been found to work so successfully that the alterations are only in detail, merely toning up the principle, and involve no departure from the principle of the rotary. Experience has shown that it is advisable to keep the knife wheel always running when the machine is passing over the line, even if there is no snow to be seen on the track. It soon collects as the snow shovel is pushed ahead by the locomotive, and it is more convenient to get rid of it by constantly running the wheel at a slow speed than to wait until the snow has accumulated and it is compulsory to have the wheel running at a high speed and the train at a slow speed when a snow drift is encountered. Among the improvements and alterations are the changes in the front and the lower part of the knife wheel casing, which enables the knife wheel to cut away the bank before the casing comes in contact with it, which will materially diminish the resistance in passing through hard-packed snow and ice. The roof of the cab has been strengthened and



THE LESLIE ROTARY STEAM SNOW SHOVEL.

made flush from end to end, whereas it was formerly highest over the front where the pilot is located. The number of windows has also been diminished, and the windows are divided into several small panes, so that a broken pane can be more easily replaced. The boiler is provided with a brick arch, and a single nozzle blast pipe is used, and it is anticipated that these and other minor improvements will improve the steaming power of the boiler. The weight of the rotary in complete working order is about 110,000 pounds. The rotary steam snow shovel can be seen in full operation upon the following railroads in the United States and Canada during the approaching winter, viz.: The Union Pacific Railroad; the Chicago, Santa Fe, and California Railroad; the Oregon Railway and Navigation Company's Railroad; the Minneapolis, St. Paul, and Sault Ste. Marie Railroad; the Duluth, South Shore, and Atlantic Railroad; the Chicago, St. Paul, Minneapolis, and Omaha Railroad; the St. Paul, Minneapolis, and Manitoba Railroad; the Chicago and Northwestern Railroad; the Chicago, Rock Island, and Pacific Railroad; the Denver and Rio Grande Railroad (narrow gauge); the New York Central and Hudson River Railroad; the Chicago, Milwaukee, and St. Paul Railroad; the Denver, South Park, and Pacific Railroad (narrow gauge); the Canadian Pacific Railroad; the Southern Pacific Railroad; the Colorado Midland Railroad; and the Northern Pacific Railroad—making in all about fifty rotary steam snow shovels which will be in operation on the North American continent during the coming winter. This number would have been largely increased had the different railroad companies placed their orders in time to have them built for this season, as we are aware that the Rotary Steam Snow Shovel Company have been obliged to refuse several orders during the last few weeks, they having as many orders on hand as it is possible for them to turn out before the middle of January, all of which goes to prove the complete success of this valuable device.

WIRE ROPE RAILWAY—AERIAL TRANSPORTATION.

THE systems of aerial transportation are divided into several categories, according as they are single or double or the carrying cable serves at the same time as a tractive cable or not. Upon these bases the installation arrangements may be varied in a large measure without abandoning the conditions of simplicity, strength, and ease of working that are indispensable to all mechanical constructions, and especially to aerial transportation. Proceeding according to these ideas, the Beer works have succeeded in devising a system of transportation that combines these qualities, and all the parts of which, readily accessible, form a really practical apparatus.

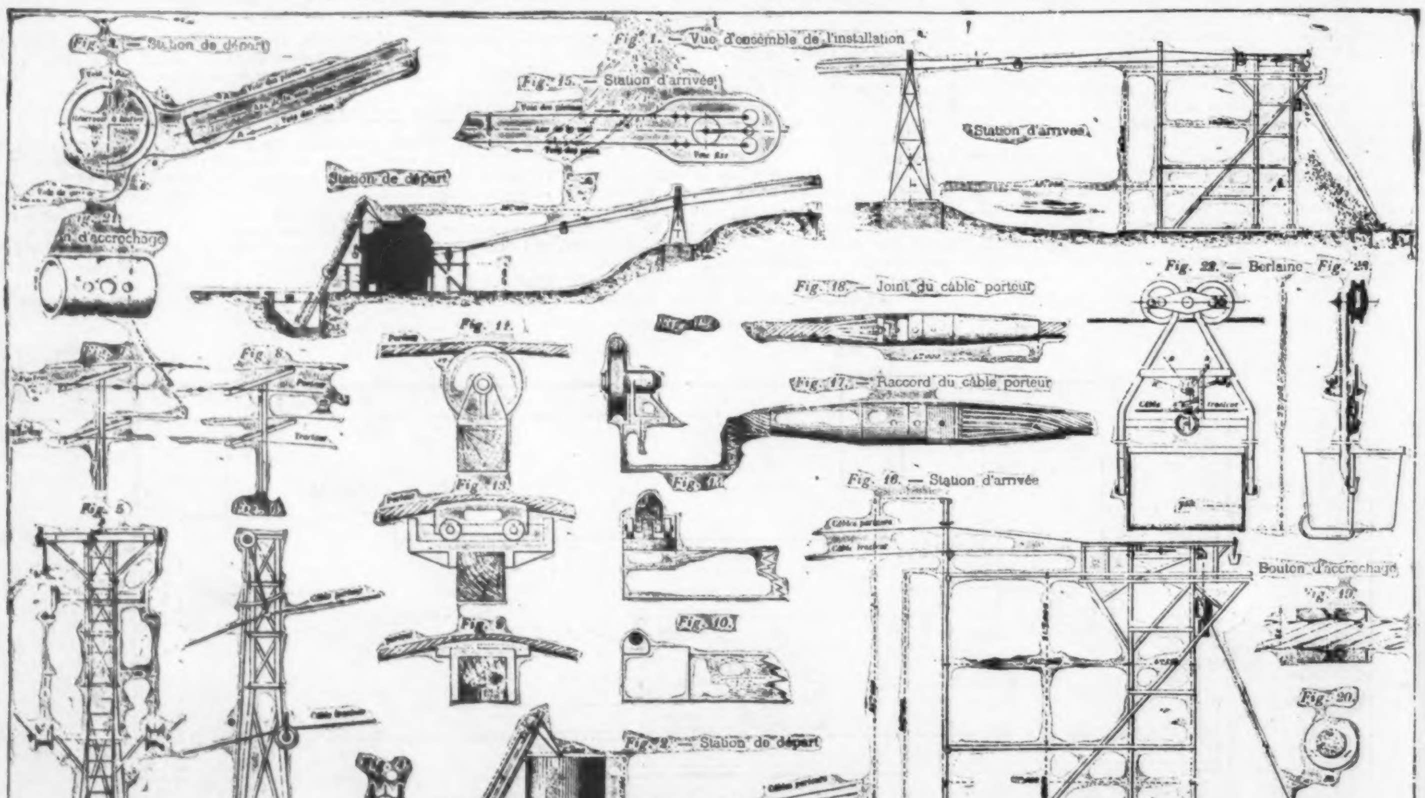
The first application of this system was made last year at the Seraing works, belonging to the Societe Anonyme Metallurgique of Esperance-Longdoz.

Before the installation of the aerial transportation, the removal of the slag was effected by leading it, on its exit from the blast furnace, by means of channels dug in the sand, to a plane area formed of thick cast iron plates. To this water was led in movable gutters, in order to hasten the cooling and facilitate the breakage. The slag was afterward broken up and carried by men to the foot of an inclined plane, where there was a strong capstan. Here it was lifted to a height of 105 feet. At the top of the inclined plane small trains were made up that were drawn by a horse to a distance of 200 yards.

The Esperance-Longdoz Society, judging this mode of carriage very onerous, resolved to granulate its slag and remove it by means of an aerial arrangement. The Beer works got the better of all competitors, and obtained the contract.

Now, the slag, on coming from the furnace, runs for a few yards in a canal that ends in the gutter where the granulation is effected. This gutter, which is of cast iron, has a rounded bottom, and the slag is so much the more finely granulated therein in proportion as it (the gutter) is longer. The output of water necessary for the granulation is about five gallons per second. The slag falling into the jet of water is granulated, and carried by a current into a basin, from which, by means of a chain and buckets actuated by a 6 H. P. motor, it is raised to an iron plate reservoir. This latter has an external diameter of 16 feet and a height of 13. The bottom has the form of an inverted cone, so as to lead the slag toward the charging spouts, located at the base of the reservoir. The latter has a capacity of 2,625 cubic feet.

The plant is constructed for the carriage of 130 tons



WIRE ROPE RAILWAY—THE BEER SYSTEM OF AERIAL TRANSPORTATION.

to a distance of 895 feet per day of ten hours. The difference in level between the platforms of the two stations is 158 feet.

In the Beer system, as in the majority of analogous ones, the entire affair consists of two terminal stations connected by two fixed carrying cables and a movable endless cable actuated by motor. The tractive cable is beneath the carrying cables and in their vertical plane. The line is rectilinear. The tractive cable carries metallic buttons which enter a piece attached to the skip, and the latter, thus connected with the cable, follows it in its motion.

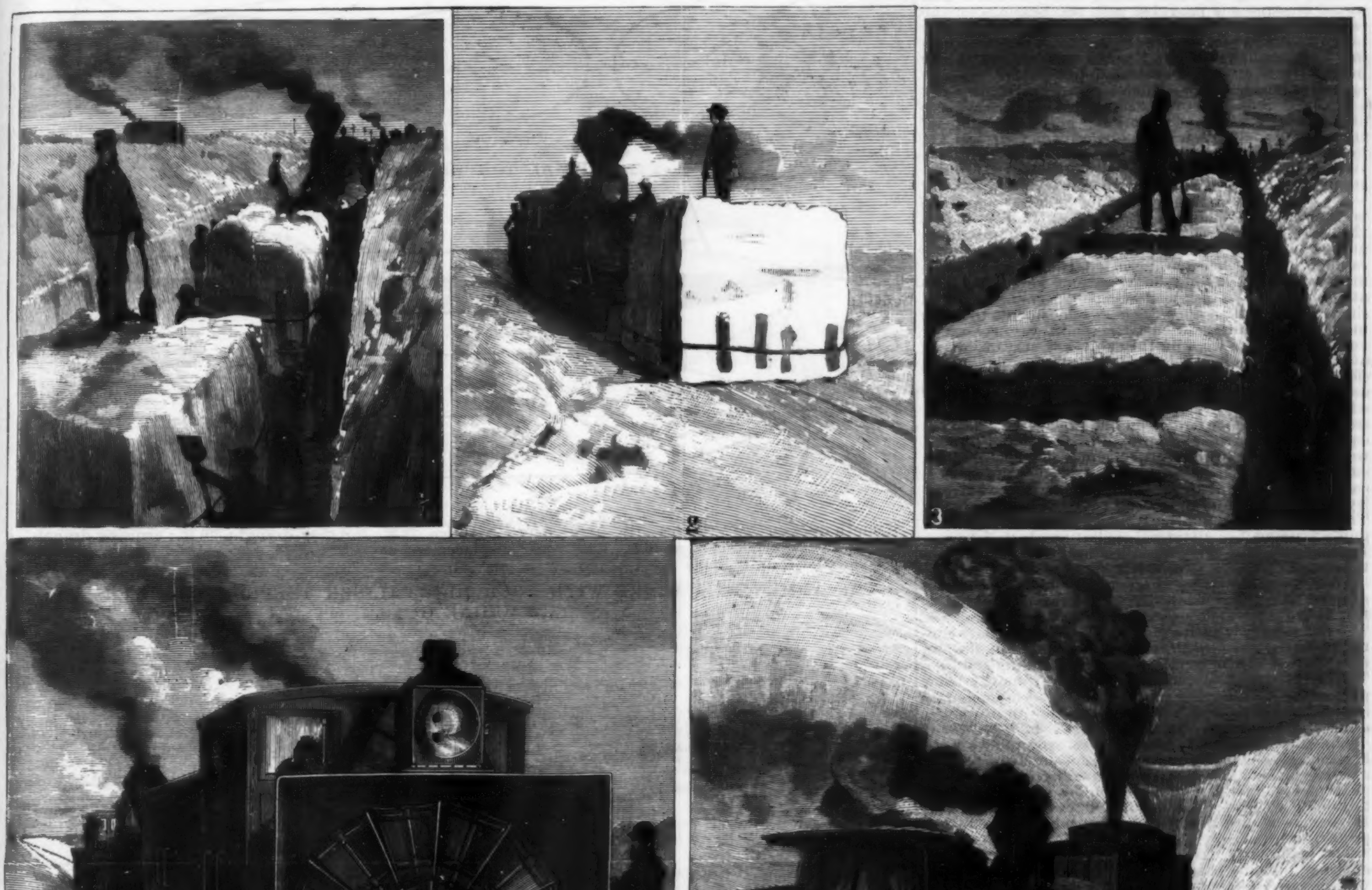
The line first rises at an inclination of 36 per cent., and after the first pole the mean inclination is 13 per cent.

On arriving at the destination, the button automatically leaves the hooking arrangement and takes up another skip, which thus returns to its starting point. The floor of the dispatching station (Figs. 2 and 3) is 11½ feet above the floor of the works, thus permitting of diminishing the initial slope, and of placing under the platform the reservoirs of water necessary for the granulation of the slag.

The station is entirely metallic. The engine, which is placed under the floor, on a level with the works, makes 120 revolutions per minute. It develops a power of 9 horses, and, through a pinion 8 inches in diameter keyed upon the shaft, actuates a large cogwheel 7½ feet in diameter, keyed upon the shaft of the driving pulley. This latter is vertical and has two channels lined with wood. The tractive cable winds around it and around another cable under it having a single channel (Fig. 4), and then passes over a vertical guide pulley parallel with the axis of the plant. The small pulleys observed between these and the hooking and unhooking points, A A, are designed to prevent the skips from getting entangled under the tractive cable.

The adhesion of the pulleys upon the cable may be increased by crossing the latter like the letter S, as shown in Fig. 4.

The carrying cables are fixed at the dispatching station by a special piece terminating in a long threaded rod held by a nut. Braces placed in front of the frame permit of obtaining a gradual slope that facilitates the descent of the skips to be hooked on, and diminishes



1, 2, 3. Common mode of trenching frozen snow on the tracks and removing it in blocks. 4. The rotary steam shovel. 5, 7. The rotary at work. 6. The track cleaned.

REMOVING SNOW FROM RAILROAD TRACKS—THE OLD WAY AND THE NEW—THE ROTARY STEAM SNOW SHOVEL.

their velocity after unhooking. Beyond, the cables are free as far as to the first of the intermediate poles. These latter are spaced 65 yards apart. The carrying cables are connected with each other by a stationary track (Fig. 3) formed of a single rail supported by brackets. This passes round the reservoir and permits of bringing the skips under the spouts. Various switches, B, facilitate the maneuvers that are sometimes necessary.

The two stations are connected by an electric bell.

Between the two stations there are three poles (Figs. 5 and 6), which are entirely of metal, and are bolted to masonry. The most elevated of these is 72 feet in height. These poles carry two crosspieces, the lower of which is provided with two rollers upon which the tractive cable rests. There are also two small iron rods for holding the cable during heavy storms. The upper crosspiece is provided with two bearings for the carrying cables. The role of these bearings is very important. In fact, under the influence of variations due to the temperature and to the stresses that occur during the passage of the skips, longitudinal displacements of sometimes as much as 10 inches continually exist in the cables. If the stresses of the two carrying cables act in the same direction (Fig. 7), a bending of the poles occurs; if, on the contrary, such stresses act in an opposite direction (Fig. 8), a pivoting occurs. So the foundation pillars resist with difficulty, notwithstanding the iron bands with which they are provided.

Let us now examine the various bearings that have been used up to the present. At first (Figs. 9 and 10) the bearing was fixed to the crosspiece in an invariable manner; but as lubrication was very difficult, the cable at length became incrusted, the entire arrangement became rigid, and deteriorations were immediate and inevitable. This inconvenience was remedied by a small pulley, which allowed the displacements to occur more readily; but, as the bearing point was necessarily very narrow, the wear on the cable was very rapid and alarming. Recourse was then had to an arrangement (Figs. 13 and 14) consisting of a piece fixed to the upper crosspiece and provided with a small carriage of a limited travel. This worked very well for some time, but in the long run the carriage on one side or the other became wedged at the extremity of its travel and refused to budge. So another arrangement was devised, much superior to the others (Figs. 5 and 6). Here the cable is carried by a bearing capable of pivoting at the extremity of a lever jointed to the end of the upper crosspiece. This lever carries a piece that slides in an angle iron guide to prevent small lateral oscillations during storms. In this way, the carrying cables are free in their motions, and the poles in nowise suffer.

The receiving station (Figs. 15 and 16) is established over an old dump heap. The flooring is situated 60 feet above this, and access is had to it by fire ladders. The framework is entirely of wood. Tension bars connected with masonry prevent all motion, and, despite its apparent lightness, the station is exceedingly stable. The carrying cables gradually descend from the front pole to the counterpoise pulleys. Each terminates in a chain that passes over a channeled pulley and supports a tautening counterpoise.

The tractive cable reaches the return pulley almost horizontally. This latter is movable in a guide. Its axle is connected by a stirrup-shaped iron with a chain that passes over a channeled pulley and supports a tautening weight. The small pulleys observed in Fig. 16 serve to secure a perfect horizontality of the return pulley.

The cable that carries the loaded skips is 1¼ in. in external diameter, and is formed of 19 one-quarter inch wires arranged in three rows. The one that carries the empty skips is 1 in. in external diameter, and is formed of 19 two-tenth inch wires arranged in three rows.

The lengths of the carrying cable are coupled by introducing the ends into a sleeve consisting of two cones, connected with an intermediate piece through two threaded ends, where they are held in place by two conical steel pins. In the first place, a doubly conical steel wedge in three pieces is inserted between the external and intermediate row of wires, and then the central pin is inserted. This latter is traversed by the central wire held by a nut.

The tractive cable is endless, and its two ends are spliced together. It carries 8 buttons, spaced 69 yards apart. The buttons are in two pieces, which are dovetailed together and connected by a bolt having countersunk heads. (Figs. 19 and 20.)

The skips are of iron plate, and swing between two uprights which are connected by two crosspieces and are suspended freely from two pulleys. The hooking apparatus is fixed to the two crosspieces (Figs. 22 and 23).

It consists of a piece movable in a slide and carrying a fixed catch, and a click that falls as soon as the button enters the device. The click falls back by its own weight, and the flat spring with which it is provided serves only for the lubrication of the cable. The movable part carries a rack that engages with a small pinion keyed to the axis of a lever, A, moved automatically by a stop fixed to the framework, when the skip reaches its destination.

On tilting, this lever lifts the whole movable part, and the button becomes free. The apparatus is closed by a lever and counterpoise, B. The apparatus is completed by a small pulley placed beneath it, and revolving under the carrying cable until the maneuver has closed the apparatus. This device works perfectly, and the skip fastens and unfastens itself automatically with remarkable regularity.—*Revue Industrielle.*

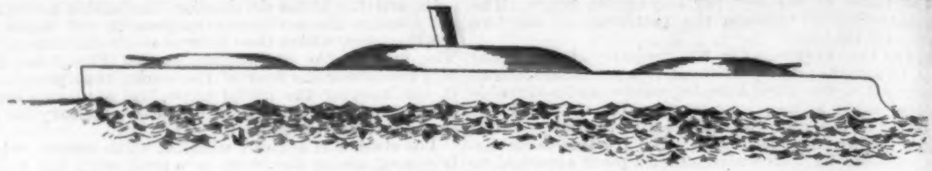
THE GRAYDON AIR GUN.

This is a new invention, having for its especial object to throw torpedoes of large or small size, as may be required. Applicable to military as well as naval purposes. Jas. Weir Graydon, late lieutenant United States navy, is the inventor.

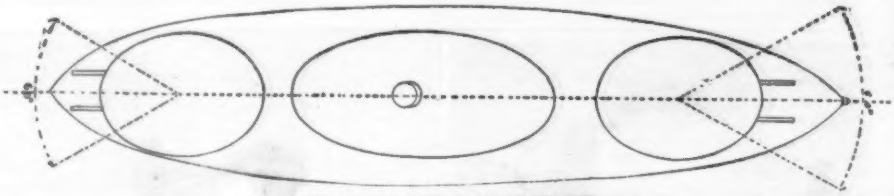
This device differs from the Zalinski gun in being very much shorter, and therefore, as claimed by the inventor, it is rendered more easy of management, while the field of its usefulness is very much enlarged. The Graydon gun is to be operated under an air pressure of 3,000 lb. to the square inch.

The Graydon guns are from 3 to 21 inches caliber, throwing from 6 lb. to 1,200 lb. of high explosives, under air pressure running up to 3,000 lb. per square inch, in varying distances up to three miles.

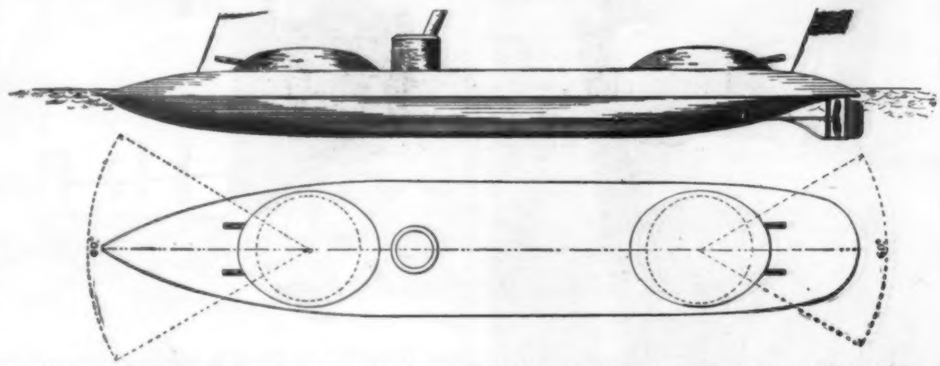
The ram invented by Rear-Admiral Ammen, of the



The Rival Air Gun Cruiser.



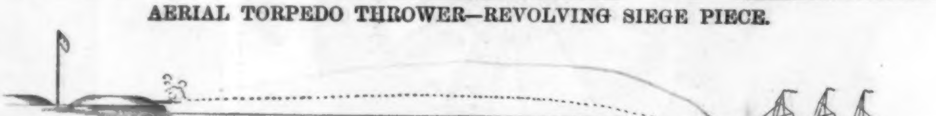
AERIAL TORPEDO THROWER.



Length over all, 224·5 ft.; breadth, 40 ft.; depth, extreme, 19 ft.; fighting draught, 16 ft.; cruising draught, 14·5 ft.; displacement at 16 ft., 1,959 tons; displacement at 14·5 ft., 1,737 tons; speed ahead, 20 knots; speed astern, 12 knots.

THE AMMEN RAM, ARMED WITH FOUR HIGH-CALIBER TORPEDO THROWERS, AND MACHINE GUNS.

AERIAL TORPEDO THROWER—REVOLVING SIEGE PIECE.



AERIAL TORPEDO THROWER.

AERIAL TORPEDO THROWER—SIEGE OR FIELD PIECE.

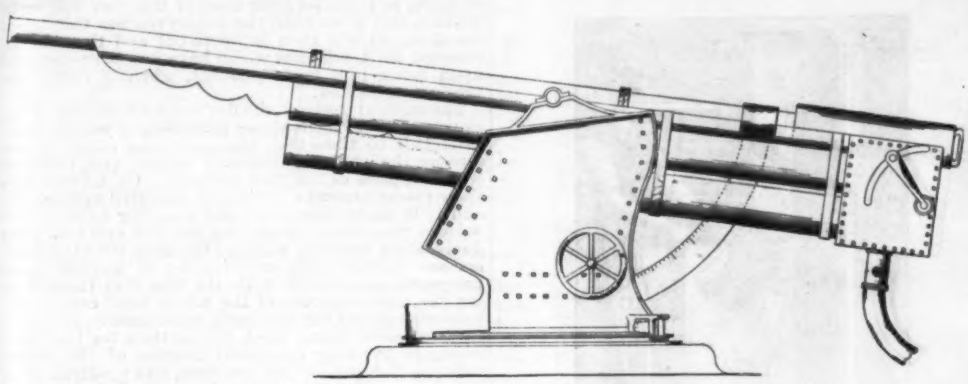
AERIAL TORPEDO THROWER—REVOLVING CANNON.

United States navy, has a speed ahead of twenty knots, and astern of twelve knots, and, by special mechanism, can be turned in her own length. A part of the armament of this powerful engine of war is intended to comprise four of the Graydon 21-inch air guns, mounted two each, in turtle-back turrets, fore and aft, having a traverse of about 60 degrees, and throwing at least two miles an enormous torpedo containing 1,200 lb. of dynamite, with air pressure of about 3,000 lb. to the square inch. These guns can be elevated, depressed, and trained like any piece of ordnance, and it is evident that when the extreme traverse point of the turret is reached, it is still possible to increase the sector of fire by altering the ship's course, in the same manner that the field of fire is obtained in the dynamite gun cruiser with the Zalinski gun. It is evident these guns can also be applied to cruisers or any other war ships.

sion in it. (No. 1.) On blowing in the free end, there will be obtained a sharp, strident sound, somewhat recalling the noise made by large grasshoppers, if care be taken to produce the sounds at close enough intervals.

If a piece of reed be so cut as not to damage the membrane that lines the interior (No. 2), and one sings in one of the ends of the instrument, the exact sounds of the reed pipe will be obtained. There is no need of cutting both sides of the reed. One will suffice. On putting the reed crosswise in the mouth, in such a way that the membrane comes between the lips, and on singing through the nose, the effect will remain the same.

The union of several reeds or other tubes, one alongside of the other, the lower end closed and the upper open, will give a mouth organ (No. 3), upon which little



1st. 5 in. military gun—Explosive in shell .... 60 lb.
2d. 9 in. military and naval gun—Explosive in shell .... 120 lb.
3d. 13 in. " " " " .... 400 lb.
4th. 16 in. military and naval gun—Explosive in shell .... 700 lb.
5th. 17 in. " " " " .... 900 lb.
6th. 21 in. " " " " .... 1,200 lb.

AERIAL TORPEDO THROWER.

For military purposes ashore, Lieutenant Graydon proposes to mount the heavier calibers in seacoast fortifications, either in turrets or *en barbette*. Smaller calibers can be mounted on field carriages as part of a siege train, or as field pieces proper, like an ordinary light artillery battery, the limber carrying the air compressors and the projectiles only, the ammunition being supplied from the circumambient air.

A revolving gun of five tubes, *a la* Hotchkiss, of about 3 inch caliber, throwing cases containing about six pounds of dynamite, is also proposed. Mounted and served as a field piece, the destructive effects, when employed against columns of infantry, are evident. Afloat or ashore, firing about 75 rounds per minute, it will be seen that, at short range especially, this is a most destructive weapon.

These field pieces will be no more cumbersome than the ordinary steam fire engine, and a four or six gun battery of them will be much less complicated than an ordinary light artillery battery.

The variety of projectiles that can be supplied is very great. For short-range firing, with the field and siege revolving torpedo throwers, this company proposes to supply dynamite cases of shrapnel and canister, and for the higher calibers, dynamite stands of grape, to be especially employed in raking fore and aft, and for enfilade firing at short batteries.

The projectiles are to have a flexible kite-tail attachment that takes up no storage room, while it performs the part of guide and balance.

EASILY MADE MUSICAL INSTRUMENTS.

TAKE an oat culm or the culm of any other cereal still green, having a knot on one side and the other side being free, and make a simple longitudinal inci-

airs may be played if the tubes are attuned according to the gamut.

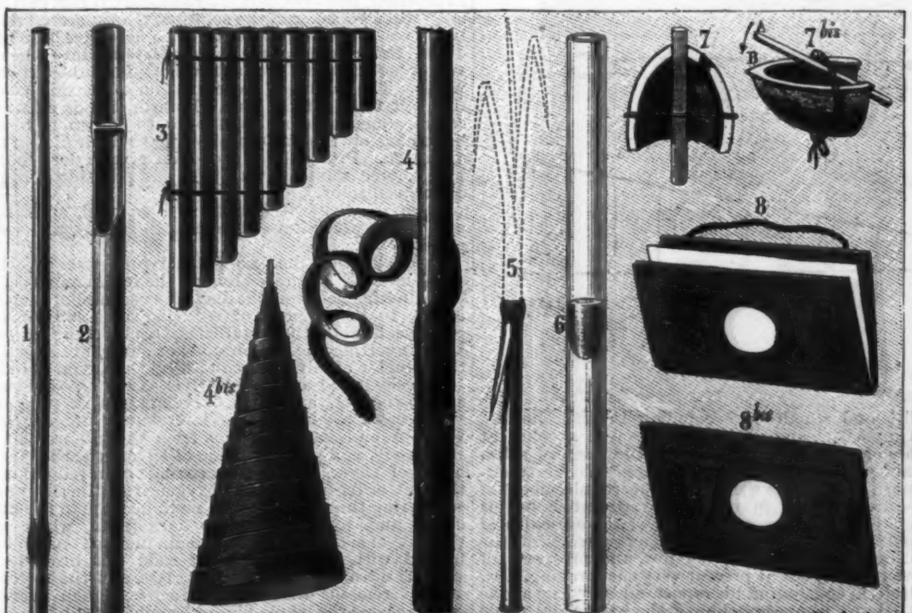
To make a flageolet, select a smooth willow branch of the desired length, and, after beveling off one end, remove the bark. Then put the beveled piece back in place after properly cutting it, so as to allow of the passage of air. Next, with the remaining cylinder of wood, a piston is made and inserted in the tube. It is clear that the deeper the piston is inserted, the sharper the sound will become. With a little skill and patience, it will become easy to play various airs with this instrument.

The manufacture of the hautboy is based upon the same principle of decorticating wood which is in sap, but it differs in construction. Here it is necessary to take a branch of willow or other tree, about $1\frac{1}{4}$ inch in diameter and 3 feet long, and cut a spiral in it (No. 4). After the bark has been peeled, the spirals are wound around each other in such a way as to overlap them slightly. In this way there will be obtained a long cornet, the back spiral of which is fixed by a thorn. (No. 4 *bis*.) Next, a small branch, a quarter of an inch in diameter, is peeled, one of the sides on the two opposite faces is thinned, the thin edges thus obtained are slightly juxtaposed, and the uncut end is introduced into the hautboy. When this instrument is blown, a very loud sound is obtained, recalling that of the hautboy or bassoon.

A cheap pitch pipe may be made as follows: Take a small glass or metal tube about a quarter of an inch in diameter, or even a piece of reed or a cardboard tube, and introduce into it a small cork to a depth of $1\frac{3}{4}$ inches, by means of a small rod of measured length. This makes an excellent pitch pipe, which, according to use, gives the medium la_3 note of the female voice, of the center of the piano, and nearly the second string of a well tuned violin. If ut_4 be preferred, make the tube about $1\frac{1}{4}$ inches in depth.

No. 7 represents the cricket known to schoolboys. It is made with a nutshell and a stick held by a twisted cord.

Finally, the following is a method of making a very simple reed pipe: Take the cardboard cover of a package of cigarette paper and make two apertures in it, facing each other and half an inch in diameter. Leave one-half of the paper within (No. 8), close the covers (No. 8 *bis*), and play as with an ordinary instrument of the kind.—*La Nature.*



SIMPLE MUSICAL INSTRUMENTS.

THE LOOMIS FUEL GAS PLANT AT TACONY.

THE Loomis Gas Machinery Company has nearly completed the plant built by it under the patents of Burdett Loomis, of Hartford, Conn., at Tacony, Pa., in connection with the saw and file works of Henry Disston & Sons, at that place, a suburb of Philadelphia. While this particular plant is housed in a corrugated iron building, 40 ft. × 98 ft., a works of the same capacity would only require a structure 22 ft. × 60 ft. Among the numerous systems designed to meet the growing demand for gaseous fuel for domestic and factory use, that of Mr. Loomis has occupied a prominent place. For three years a Loomis plant for manufacturing illuminating gas has been in operation at Cottage City, Mass., while the first fuel gas plant has been running regularly for over a year at the works of the John Russell Cutlery Company, at Turner's Falls. The works at Tacony have been in partial operation for some time past, while a large fuel plant is being built in connection with the Addyston Pipe and Foundry Company, at Addyston, O., near Cincinnati. A contract has been closed lately for a large plant for manufacturing gas for factory and city use for Akron, O., an illuminating works for Kenosha, Wis., and a fuel plant for the Waltham Watch Company, at Waltham, Mass., to furnish gas for all its boilers, forging, crucibles, annealing furnaces, soldering, tempering, etc.,

The leading point in which the Loomis system differs from other methods of manufacturing water gas is that the generator is run by down draught during the period when the coal is being brought to incandescence to decompose the steam passed through it in an opposite direction to manufacture water gas. The process, therefore, consists of two distinct periods, producing two products: (1) generator gas made during the period of blasting, when air is drawn through a column of fuel downward by an exhauster; (2) water gas produced by allowing steam to enter from below into the column of incandescent fuel, being carried off by a series of tuyeres in the generator above the fuel line. The advantages claimed for the down draught system are that when the coal is being made hot during the blasting period, preliminary to the manufacture of water gas proper, the volatile gases passing down through the hot coal are fixed. In other words, the troublesome tars, etc., are decomposed. The down draught system, it is claimed, tends also to reduce clinkering, there is no poking from the top, and the coal is charged during the blasting wherever spots of fire begin to show.

The Tacony plant consists of four generators, having a 9 ft. outside diameter, 6 ft. diameter fire box, and 14 ft. height, with a fire brick grate and an air-tight charging hopper. Connected with the ash pit is a vertical cooler, 2 ft. in diameter and 18 ft. high, the generator gas being drawn through its thirty tubes by a No. 3 Roots exhauster, the office of the cooler being to reduce the temperature of the generator gas made during the blasting period from 500° to 600°. In this manner the injurious effects upon the exhauster of sudden and great fluctuations in temperature are avoided. The water in the cooler is used to feed the boilers, so that the heat is not wasted. The rest of the plant consists of a Heine boiler, set to be run with generator gas, which furnishes steam for two 9 × 12 engines, made by the Phœnix Iron Works, to drive the four exhausters, one engine being used for the day turn and the other for the night shift.

There was being built, too, at the time of our visit, a set of retorts of special design for manufacturing illuminating gas with the water gas as a basis, the foundations for the purifier being completed, while the last touches were being put to two holders, one of 20,000 ft. capacity for water gas and one of 30,000 ft. capacity to be used for illuminating gas. Now it is being employed to measure the quantity of generator gas consumed and made. We may mention that the company have laid over a mile of pipe in the village of Tacony, and that a number of houses have their connections completed for fuel gas. The company have fitted up a room with stoves, lamps, etc., to show the domestic applications of the gas.

Turning now to the results obtained, it is stated that the relative proportions of generator and water gas show a production of 130,000 ft. to 140,000 ft. of the former and from 40,000 ft. to 50,000 ft. of the latter, according to the character of the coal used. Any kind of bituminous or semi-bituminous slack coal may be employed. So far as the employment of anthracite culm is concerned, we are advised that, since the Tacony plant was built, especially for bituminous coal, it has not been determined how far it is possible to go with it as a part of the mixture.

Thus far the maximum has been two-thirds of anthracite culm and one-third of bituminous coal. The 6 ft. generators at Tacony each have a capacity for gasifying eight tons of coal per twenty-four hours, and it is estimated that the size now contemplated for subsequent plants, 7 ft. diameter of fire box, will convert ten tons daily into gas. When running on generator gas alone, as large an amount of steam is introduced into the generator as is consistent with a continuous run, so that the product is a gas which practically is intermediate between the ordinary Siemens producer gas and pure water gas. The Tacony plant, which was built under the supervision of Mr. S. T. Williams, general manager of the steel works of Messrs. Disston & Sons, has been used for some time past to test the value of fuel gas in its application to the different departments of these works.

At the time of our visit the striking differences in the convenience of using solid and gaseous fuel were well illustrated in the forge and hardening shops of the works. In the file-forging shop a number of the gas and coal forges were at work, though the latter are being taken out as rapidly as possible. The contrast

in cleanliness, ease of supervision, comfort to the men, and uniformity of heating was remarkable, and even though the comparative cost has not yet been ascertained, these incidental important advantages would insure the employment of gas even if there were a balance against it. In the saw-hardening department one furnace has been remodeled to use gas, and others are following. There, too, the same features are striking, being coupled besides with a decided gain in the amount of work one man can do and with the advantage that the entire handling of coal and of ashes is dispensed with, and that it becomes possible to economize considerably in floor space. For some time past Loomis generator gas has been used in a Siemens reheating furnace with a 7 ft. × 12 ft. hearth, used in connection with an 18 in. bar mill. According to the superintendent, its superiority over ordinary Siemens producer gas has been well shown in the smaller consumption of gas and in the more rapid and better working of the furnace. Permanent connections are now being made with the main mill, and fuel gas will be used exclusively. Gas flues are being laid to connect with all boilers in the steel works, and they, too, will be fired with generator gas.

Thus far only the generator gas has been employed in the heating furnace. Later on a practical demonstration is to be made with the use of pure water gas in a Siemens furnace. It is claimed that the saving of labor in running these Loomis generators on generator gas over the Siemens producers is very large, one man doing the work of three; and the gas is made under pressure and can be carried to any number of furnaces direct, without use of stack draught and the flow regulated perfectly.—*Iron Age.*

FLAX SCUTCHING IN IRELAND.

THIS operation is at present carried out in Ireland in two different ways, viz., by hand and by machine—the latter system prevailing in the chief agricultural districts, and the former in the more isolated districts of the country. Preparatory to scutching, however, crushing the flax, in order to break the shrove and make it more easy to separate from the fiber, is resorted to. The system universally in use in Ireland for this purpose is simplicity itself, although dangerous to those intrusted with the work. The machine consists of two pairs of iron fluted rollers about 8 in. in diameter, both of which work close together, and revolve in the same direction. The flax stalks are fed into the first pair directly by hand, without the application of any traveling apron or feed arrangement, and are delivered loosely upon the floor or ground by the second pair. The top rollers are heavily weighted, and so between them and the bottom ones the crushing is accomplished. In numerous instances the attendants at these machines have had their hands drawn in, and as a result have lost fingers, hands, and even arms, before being released. Lately, however, the attention of machinists has been concentrated toward producing a combined crusher and scutcher, but with comparatively little success; and scutch mill owners refuse to pay for elaborate machines with feed and delivery lattices and all the necessary framing and gearing, when the object of the process is exactly similar to that of the rollers which they already possess.

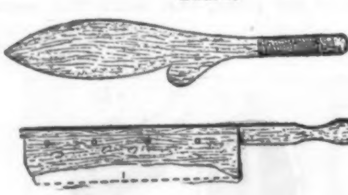
In hand scutching, the entire appliance necessary is a board of wood, about 4½ ft. high, 18 in. broad, and 2 in. thick, placed in a vertical position. Near the top of the board a hole of about 6 in. diameter is cut, through which the operator passes a bundle of the stalks. The ends of these close to the board he holds tightly in his left hand, while with his right hand, in which he wields a wooden beater (two specimens of which are shown in Fig. 2), he beats projecting stalks rapidly in a downward and slightly oblique direction. This breaks up the outside membrane into fibers, and removes the internal woody part, which of course falls to the ground. Hand scutching is attended to generally by the field laborers after all the crops have been gathered in. In machine scutching, considerable diversity of arrangement exists, the machines in use for the purpose being many and varied. The system of manipulating the material is, however, the same in all of them. Some machines have iron blades, a few whalebone, while 75 per cent. of the whole are made of wood. Some of the first named are almost entirely self-acting; but the others, to complete the operation, are attended by a combination of mechanical and manual labor. Our illustration (see Fig. 1) shows by far the most general form of Irish flax scutching machines, the arrangement of the mills and the operation being as follows: A shaft, C, passes through a series of boxes, of which one is shown in the figure. Each box is divided into two compartments, A and E, in the former of which the beaters revolve, while in the latter are a set of shelves, on which the sheaves of flax are laid for convenience. The operator also stands in this compartment, and, selecting a bundle of stalks, he allows them to project over the board, D, as shown, when the blades, B, revolving rapidly, strike the material in a downward direction, and so break up the fiber and knock out the woody core. With the wooden beater the action on the material is comparatively gentle, and does little or no injury to the natural properties of the fiber. Iron blades have many times, and in many forms, been substituted, but they have always been discarded for the ordinary system, which has now been in existence, with slight modifications, during the past century. This has been due to the opinion of farmers and experts that iron blades, being rigid and unyielding, exercise a decided tendency to break the fiber.

Within the past year, however, three entirely distinct scutching machines have been invented and brought to public notice. In the general arrangement of a modern scutch mill of considerable size, the chief features noticeable are as follows: (1) That, without exception, they are driven by means of water power, steam power being in no case used for the purpose. The reason of this is easily explained. In the first place, water is very plentiful in Ireland, and its power can easily be utilized; then, again, to erect a water wheel under such advantages costs much less than to erect a steam engine, and there is nothing required in the shape of fuel or of attendants and firemen to keep it at work. And lastly, the most important point is, that its power is only required about three months of the year, after the harvest time, and therefore it remains idle during the other nine months. In the internal arrangement of the mill, a series of scutching compartments goes along each side, and at each of these a beater, with four, five, or six handles or blades, revolves, one attendant being required for each compartment. The charge for scutching flax varies slightly in different parts of the country, but on an average it costs about 10d. per stone. This sum may appear very large, and the actual cost of the process is much less; but scutchers charge rates sufficient to defray the cost attendant on their unemployed machinery during the remaining portion of the year. Farmers who have a few scutching handles of their own can do the work of their own crops at a cost of about 6d. per stone, which, on the production of several acres, amounts to a considerable saving. From the open and uncovered manner in which the process of flax scrutching is conducted it may well be supposed that the dust generated in and floating on the air of a scutch room must be very great,

FIG. 1.

and render it injurious to health; and this is actually the case. Dr. Hamilton, the certifying surgeon of Cookstown, in his report of the flax scutchers of the district, made the following statements in 1875: "The scutchers, men and boys, work by piece work, and get a percentage on the finished flax of so much per stone; consequently, they frequently work late at night to make the more wages. Many of these small mills have only five or six handles, one scutcher working at each handle. The places are badly ventilated, and have low roofs. The dust and spiculæ driven off the flax are quite thick in the atmosphere, which the workers have to breathe at all times, and which produces irritation of the air passages, and an almost constant cough and spitting of blood, very frequently ending in phthisis. Ophthalmia also is due to this dust, sometimes ending in opacity of the cornea, which would be more frequent were it not for the intervals of the spring and summer months enabling the workers to recruit their strength in agricultural labor. The permanent injury to their health would, but for this recruiting, be far more serious, since their habits are very careless and intemperate, so that 'as thirsty as a scutcher' is a common saying here. The rollers at which the flax is broken for the scutchers are attended by one person, frequently a woman, who has to breathe the same kind of atmosphere, but, in addition, is liable to very serious injury from being drawn into the rollers by a portion of the flax straw catching round her hand. . . . The use of the bath is almost unknown among the workpeople,

FIG. 2.



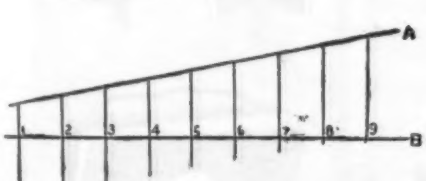


FIG. 3.

and dirt and squalor are common in their houses, and in my visits among them, I am often shocked at the state of their bedclothes and at the want of suitable healthy ventilation of their houses." This interesting report, which was written for the requirements of the factory acts, is in no way exaggerated, but is characteristic of the great majority of the agricultural districts. Industrially and socially the grade of the agricultural population is very low, and prospects of improvement are not at present very encouraging. Dr. Hamilton, in concluding his report, adds: "The above report is but a meager outline of the habits and mode of life of those engaged in the preparation of flax for the markets, and any improvement that may take place in their workrooms will be by steam power and large buildings being erected, instead of the wretched hovels now in use, and the introduction of improved machinery superseding the present primitive structures in most country districts."

In machine scutching or wholly mechanical scutching, the general system of operation, regardless of the form of construction, is to fasten a bunch of the straws by their ends in an iron holder. This holder moves down an inclined plane, under which revolve cylindrical beaters, or in other forms the holders traverse along a framework, which rises and falls by means of a cam motion or some other mechanical arrangement. The diagram in Fig. 3 will illustrate the principal of work in the former machine. If A is the inclined plane on which the holder slides, B the beater blades, and the ordinates represent the position of the pendent flax at different positions of the holder on the slide, then the corresponding points of contact between the blades of the beater and the material will be at 1, 2, 3, 4, 5, 6, 7, 8, 9. At point 9 the beater blade will not touch the stalks, at point 8 the lowest extremities will be operated upon, at point 7 a little more of the fiber will be in contact, and so on until the holder reaches the end of the slide. It will then be taken out and the material reversed in it, the ends which have not been operated upon being now made pendent, when of course the process is repeated.

Throughout Ireland the flax markets are numerous, every center of agriculture possessing a weekly market. It is to these that the agents and buyers representing the spinning industry repair, and purchase their supplies of the raw material. On market days these places present a lively and animated appearance, and it is really interesting and amusing to watch the various purchasers inspecting the flax and hear their deprecating remarks, while at the same time the farmers are industriously endeavoring to impress their prospective customers with the idea that theirs is by far the most superior of the whole local crop. The price of scutched flax fluctuates considerably, the prices for this season being much higher than for last year, owing to the long continued drought of 1887, which reduced the production per acre, and rendered it of inferior quality and value. Quotations, however, at the various markets throughout the country in January of the present year averaged as follows: For well scutched flax, the lower grades commanded about 4s. 6d. to 5s. per stone, the medium from 5s. to 6s. 6d. per stone, and the finer qualities from 6s. 6d. to 8s. 6d. per stone. Hand scutched flax, of corresponding qualities, averaged respectively 3s. to 3s. 9d., 3s. 9d. to 4s. 6d., and 4s. 6d. to 5s. In scutching flax the great aim of a careful scutcher is to thoroughly separate the fiber from the straw with as little waste as possible. Of course there must necessarily be more or less short fiber removed along with the unworkable matter, the percentage of loss in this way being greater when the retting process has been incomplete. This short fiber, when removed from the woody droppings, is termed "scutching tow" or "codilla," and in that condition is sold to the spinners and manufacturers of the coarser fabrics, such as sacking, etc. Good flax fibers, or fibers which have their natural properties fully developed and have been in no way injuriously affected by the preparatory processes, should (when scutched) be of a bright silver gray color and glossy in appearance. Fibers which are dark in color or of a greenish tint are either of a naturally inferior quality or have been reduced in value by imperfect manipulation.—*Industries.*

PYRO, HYDROCHINON, HYDROXYLAMINE, AND NEUTRAL OXALATE USED AS DEVELOPERS OF PHOTOGRAPHIC DRY PLATES.

WHEN using the various developers, how many photographers think of the fate of the subtile mixtures poured on the dry plates and of the resulting mixtures remaining in the tray? A few glances at the attributes of the substances so familiar to all, bearing on the chemical properties called for and the reactions desired, may be of interest.

Pyrogallic acid is made from gallic acid by sublimation; gallic acid, $C_7H_6O_5 + H_2O$, heated in a stream of carbonic acid sublimes in crystalline form, yielding a new product, $C_6H_6O_3$. This is the approximate result, but it gives an idea of what occurs. The snow-white crystals are soluble in two and one-half parts of water, taste bitter, do not give an acid reaction, and the dry acid does not decompose readily by exposure to air. In solution, however, it readily absorbs oxygen, particularly when warm, and the solution, if evaporated slowly, leaves a brown powder of some decomposition product. Bromine converts the dry crystals into a heavy yellow substituted product, almost insoluble in cold water. The slightest trace of iron protoxide colors this salt to an intense blue. Potash, or soda solution, colors aqueous solutions of pyro to brown or black, beginning on the surface, showing that air aids in the oxidation. Protosulphate of iron gives a deep indigo blue colored solution, with pyro and peroxide of iron a dark green color.

From solutions of mercury, silver, gold, and platinum pyro precipitates the metals readily and completely.

Pyrogallic acid has no distinct properties of other acids, and can be classed among the indifferent bodies, being neither acid nor alkaline. Its use in photography is due to its property of reducing silver salts in the gelatine film to the metallic state, absorbing oxygen, and converting the sub-bromide of silver, not affecting the bromide of silver unreduced by the action of light.

Suppose sub-bromide of silver exists on the plate after exposure, and then, developing with pyro and soda, there commences an interchange of elements. First, bromide of soda forms from the sub-bromide of silver only, and possibly oxide of silver or carbonate of oxide of silver. Pyro then commences a reduction of this salt or base, absorbing oxygen from the silver and converting the film into the metallic state in the high lights and tones, while the dark parts, where the bromide of silver still exists, remain unacted on. When treated with hyposulphite of soda this bromide of silver is dissolved, leaving clear glass, and the metallic deposit remains undissolved. In very much over-exposed plates the whole film of bromide of silver is converted into sub-bromide, and the pyro deposits a continuous surface of metallic silver; hence the absence of details to make contrast. It is well, in order to avoid stains and even loss of negatives, to use fresh pyro solution, clean pans, and exercise care in development.

But among the new-born wonders we have a reagent almost identical in chemical composition with pyro, not produced from nut galls, as pyro is, but from gas coal tar, or more properly from aniline, a product from chemical reactions of complicated nature on coal tar, and one that has made a tremendous bound into the world of photography, being looked upon as the equal or superior of pyro. This substance is the now well known hydrochinon. In the chemical books of thirty years ago this reagent is barely mentioned, while pyro was well known and fully described. Although hydrochinon was discovered by Wohler in 1844, and described as an interesting product from chinon by distillation of kinic acid, a by-product of cinchona bark, it remained hidden for photographic purposes until recently. Hydrochinon consists of $C_6H_6O_2$, pyro is $C_6H_6O_3$, varying, thus, by the absence of one equivalent of oxygen, although produced from such a widely different source.

It is not necessary to go over the complicated methods of manufacturing hydrochinon. A few hints as to its attributes must suffice.

It crystallizes in colorless, transparent rhombs, is soluble more readily in hot water, also in alcohol and ether. In the presence of platina, sponge, or charcoal, in aqueous solution, hydrochinon is decomposed into chinhydron, $C_6H_5O_2$. Chinhydron is precipitated from a solution of nitrate of silver. A caustic alkaline solution mixed with it is soon colored by exposure to air.

Doubtless owing to its great affinity for oxygen came the discovery of its value in photography. While working slower than pyro, it undoubtedly gives most beautiful results, making negatives with the good properties of neutral oxalate development, and, not being so readily decomposed as pyro, does not stain gelatine plates or soil the fingers.

Hydroxylamine muriate is the chloride of the amide of hydroxyl in chemical parlance, or, if this is too complicated, water among chemists consists of hydrogen 2, oxygen 1=HOH. Removing one of the hydrogen atoms, a hypothetical radical (for it has never been isolated), called hydroxyl, remains, and the lost equivalent of hydrogen can be replaced with the radical of ammonia, NH_2, and then a new body called hydroxylamine, NH_3O, results, possessed with remarkable attributes, combining with acids and gases to form new bodies, among many being muriate or chloride of hydroxylamine. This substance crystallizes from a hot saturated solution in acohol in large, clear, colorless crystals, not unlike nitrate of silver in appearance, which decompose quickly into water, muriatic acid, chloride of ammonia, and nitrous oxide gas. The crystals are readily soluble in water, and then have a pronounced reducing effect on silver salts, precipitating metallic silver. Hydroxylamine, also, readily reduces silver solutions, more particularly in alkaline mixtures, though also in neutral or acid ones. Dr. Charles E. Mitchell has published a most interesting paper on the use of chloride of hydroxylamine with pyro as a developer for gelatine plates, which is worthy of perusal. His negatives were superb, and he claims, in addition, that the mixed pyro and hydroxylamine is very stable and lasting.

Neutral oxlate of potash and proto-sulphate of iron, when mixed, give a new combination in solution. The potash combines with the sulphuric acid, and the oxalic acid joins the protoxide of iron to form oxalate in solution. This oxalate of the protoxide of iron has great affinity for oxygen, taking it from the air or from subbromide of silver in the exposed plate, and is converted into the oxalate of peroxide of iron. It does this in developing plates, and reduces the silver film to the metallic state, rendering probably the best negatives by proper use on plates receiving the exact time of exposure.

Neutral oxalate of potash is made by neutralizing oxalic acid with carbonate of potash and crystallization. Oxalic acid, formerly made from the juices of plants, is now almost entirely produced from sawdust by complicated chemical processes.

So these valuable, we might say invaluable, reagents come from very humble sources. Pyro from oak balls, hydrochinon from coal gas tar, hydroxylamine from water, and neutral oxalate from sawdust, but not without the intervention of great thought, colossal work, and indomitable energy of some of the greatest chemical experimenters, and in using them great respect should be given to the memories of men who worked for the love of science and without expectation of reward.—*Science of Photography.*

THE GROSVENOR GALLERY CENTRAL LIGHTING STATION OF THE LONDON ELECTRIC SUPPLY CORPORATION.

THE total number of lamps at present wired in connection with the Grosvenor Gallery Station is equivalent to about 35,000 of 10 candle power, but it has hitherto been found that 20,000 represents the maximum number in use at one time, and this number is but rarely exceeded. To supply currents for these lights, two Ferranti machines are provided, each of which was designed for 10,000 10-candle power lamps, but one machine alone has proved itself capable of taking a load of no less than 19,500 lamps without injury. These machines stand 9 ft. 6 in. in height, with a floor space 9 ft. by 11 ft. The armature is not built up in the way usually associated with the name of Ferranti, but is composed of separate bobbins, after the Siemens type. The coils are wound on laminated cores of gun metal and German silver, and are composed of copper tape ½ in. in width by 0·06 in. in thickness. The tape is slightly corrugated in order to prevent its slipping on the crown of the core, which is also corrugated to receive it. The insulation is wound on with the tape, and consists of hard vulcanized fiber of ⅓ mm. thickness. One end of the bobbin is soldered to the core, which is insulated from the frame by blocks of ebonite held in cast iron clamps. In the Deptford machines we understand that an improved method will be adopted. There are forty coils, each consisting of 25 turns, connected twenty in series and two in parallel, so as to keep the points of maximum difference of potential at the opposite extremities of a diameter. The diameter of the armature is 8 ft. 6 in., and its resistance when hot 1·1 ohm, which at 2,400 volts gives a loss of only 7,000 watts, or 1·36 per cent. on the maximum output. The speed is 260 revolutions per minute, which is equal to a peripheral velocity of 6,942 ft. per minute. The field magnets are eighty in number, and are set very close together, forty on either side. The coils are connected in eight parallels, and have a resulting resistance of one ohm nearly. The field magnets weigh 17 tons, the base plate 13 tons, the pulley (diameter 5 ft.) weighs 2 tons, and the armature one and a half tons.

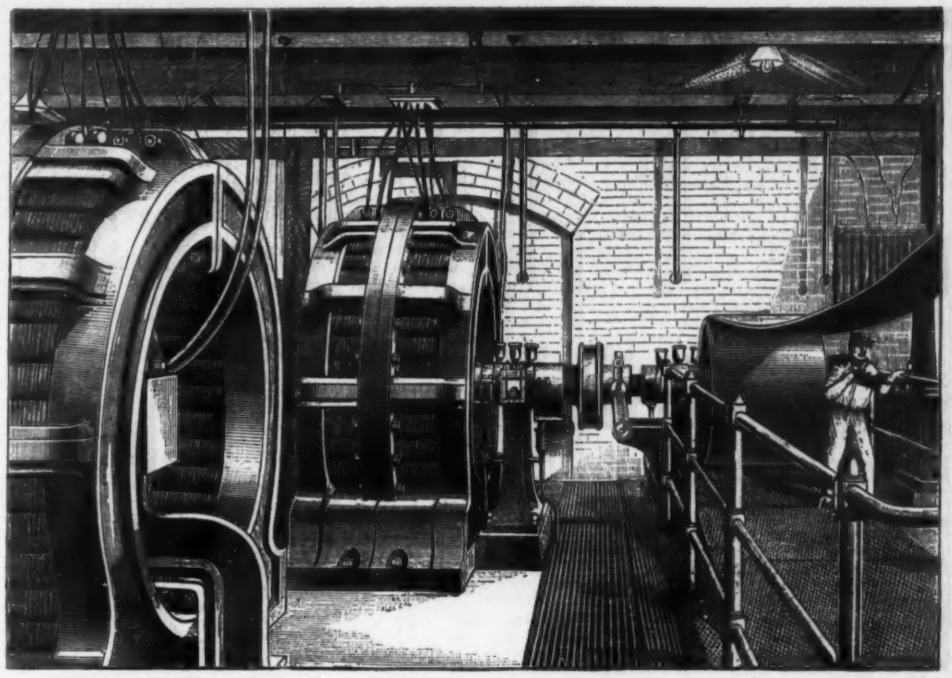
The exciters are shunt-wound Siemens machines, giving 100 volts and 108 amperes; they are coupled direct to the shafts of the Ferrantis. The latest addition to the plant is a twelve unit Kapp machine, also shunt-wound, which is at present used chiefly for lighting the engine room, but is also intended as a stand-by for the exciting current in case of need. Switches are arranged for this purpose. There is a constant oil service for each of these machines; the tank holds 300 gallons, and the circulation is effected by two Worthington pumps. Castor oil is used, and the used oil is returned through two strainers.

The engines are four in number, two being Marshall single cylinder horizontal engines, of 35 horse power nominal; one a coupled engine, similar to the above, capable of developing 500 horse power actual; and one a Corliss, by Hick, Hargreaves & Co., of 750 horse power. The Marshall engines run at 80 revolutions, and drive on to a single countershaft with clutches so arranged that very nearly any desired combination of engines and dynamos may be effected. The smaller engines have 19 in. cylinders with 3 ft. stroke, and fly-wheel 13 ft. in diameter. The coupled engine has 17 in. cylinders, with 3 ft. stroke and fly-wheel 12 ft. in diameter. The Corliss engine has 33 in. cylinders, with a 4 ft. stroke, and a fly-wheel 18 ft. in diameter. One of the large machines is driven direct from the fly-wheel of the Corliss engine by rope gearing. The other machine is connected by means of a claw clutch with the countershaft driven by the Marshall engines, as already described. The clutch has been specially designed for this purpose by Mr. Ferranti, and it is so effective that when the machine is loaded to 400 horse power a change can be made without any perceptible effect upon the lamps.

The regulation of the dynamos is effected solely by the governing of the engines. Ordinary centrifugal governors of Hartnell's type are used, and the speed is regulated in accordance with the indications of a Cardew voltmeter by means of a weight sliding on a lever arm. Nothing is more striking in the whole installation than the simplicity and effectiveness of the governing arrangement. The Cardew voltmeter is used only as a "voltascope"—that is to say, it is connected with a small transformer, and its indications are on an arbitrary sale.

The steam generating plant consists of a battery of four Babcock & Wilcox boilers, each of 150 horse power, worked at a pressure of 130 lb., and blowing off at 135 lb. When the station is in full swing, all four boilers are required, so that there is practically no reserve. The fires are only drawn on Sunday. The water tank contains a three days' supply, and there is storage capacity for thirty-six tons of coal. The average daily consumption amounts to 23 tons. The boilers are placed in an excavation, this room being connected with the engine room by a tunnel 40 ft. or 50 ft. in length, which also serves as a ventilating shaft. The offices and stores are above the boilers, with the water tank, on the top story. The ventilation is effected by means of a 72 in. Blackman air propeller, running at 200 revolutions, which is found to do its work with remarkable efficiency.

Coming now to the circuit arrangements and the distributing plant—the current passes direct from the machines to a pair of Sir William Thomson's ampere balances, capable of measuring 250 amperes. The maximum current taken off each machine is about 210 amperes. The machines are run independently, that is to say, they are not electrically coupled in parallel. The external circuits are five in number, and the main switches are specially designed by Mr. Ferranti for



THE 10,000 LIGHT FERRANTI DYNAMO AT THE GROSVENOR GALLERY, LONDON.

MORNING. NOON. NIGHT.

CURVES OF CURRENT OUTPUT AT GROSVENOR GALLERY.

The dotted curve was taken on Monday, October 29, and the upper curve on November 1, when a dense fog occurred.

breaking on the high tension of 2,400 volts. The break is no less than 4 ft. in width, and is made with great rapidity. The main fuses of the switches are each about two feet in length, and consist of tin wire, several fine wires being joined in parallel. They are mounted on plugs provided with long ebonite handles, by which they can be readily replaced. It is, however, a very rare event for a fuse to go off.

The main wires on the overhead circuit are all of 19/15 strand cable, insulated with rubber and braid, suspended by leather thongs from 17/16 steel cables. The thongs are about 7 in. in length and ¾ wide. The steel wire is shackled off at each pole, and Johnson & Phillips' well known oil-cup insulators are now exclusively employed. The insulation resistance of the line amounts as a rule to about 3,500 megohms per mile. On the roof of the gallery is a main derrick, of iron lattice work, erected by Messrs Saxby & Farmer, designed for 12 separate circuits. On ordinary house tops iron poles of 3⅝ in. diameter are employed, and are let into cast-iron sockets in the usual manner; about 400 of these poles have been erected, and over 100 miles of wire have been run, while up to the present time not a single breakage has occurred. It need hardly be said that this is a result which reflects the highest possible credit on the engineering staff. All streets are invariably crossed at right angles. The return wire is carried over the same line at a vertical distance of 1 ft. below the positive lead, and not the least disturbance is now complained of on adjacent telephone circuits. Branch wires are usually 7/16 strand, and house wires 7/20. The external house wires are inclosed in earthenware piping, which is usually let into the wall. Before joining the transformer they pass through a safety fuse and a main switch. The junction of the primary wires with the transformer is made at the bottom of a deep groove in the outer casing of the transformer, and can only be got at by a screwdriver of extra length.

The Ferranti transformers on the consumer's premises are inclosed in a fire-proof casing, and are fixed in cellars or outhouses, or wherever a convenient place can be found. With the exception of a slight mishap at Lord Brassey's residence, of which unduly magnified accounts were circulated, no trouble whatever has been occasioned by the transformers. The main switches in the consumers' premises are all of the double pole type, the break being made instantaneously on each side. It is, perhaps, not generally known that the spark on breaking an alternating current is decidedly smaller than that which is given by a continuous current under the same conditions. It is also a singular fact that under certain conditions and within certain limits the spark is more vivid with a small current than with a larger one. On these circuits it is a fact that with a 20 ampere current the spark is less intense than with one quarter of an ampere. The insulation between the primary and secondary of the Ferranti transformer is remarkably high. The core is first wound round with several layers of linen soaked in shellac, each layer being allowed to dry slowly. An outer coating of shellac paper is put on, and over this the secondary coil is slipped. The primary coil is usually made in twelve sections connected in series, so as to distribute the potential as much as possible; the sections are separated by shellac paper. The primary is insulated from the secondary in the same way as the secondary is insulated from the core. The transformers are made in the following standard sizes: 2½ horse-power, 5 horse-power, 10 horse-power, 15 horse-power, and 20 horse-power. These figures are, however, merely nominal. Mr. Ferranti seems always to allow himself an ample margin, and we are assured that the 2½ horse-power size has easily carried a load of 61 16-candle-power lamps, which is about equal to 6 horse-power. As a rule, the transformers are designed for 100 volts at the secondary terminals. From these terminals the house wires are taken to the meter, and from the other side of the meter the wires are the property of the customer, and the responsibility of the company ceases.

By far the greatest number of the lamps supplied are 10 candle power incandescents; there are, however, a few Sunbeams, and about 14 or 15 arc lamps. Most of the latter are employed by photographers in Regent Street, and are regulated by hand. The lamps outside the Haymarket Theater are of the Brockie-Pell type, and are run two in series off a 100-volt transformer.

The adjacent illustration (Fig. 1) is taken from a photograph of the machine room, and shows the two large Ferranti dynamos. The curves of current output in Fig. 2 are of a very interesting character. It may be as well to add that the ordinates representing current may be interpreted in lamps on the basis of about 4,000 lamps for each 50 amperes of the primary current. The effect of a fog is very evident in the upper curve.—*The Electrician.*

EDWARD WESTON'S APPARATUS FOR UTILIZING SOLAR RADIANT ENERGY.

The author says: I propose to transform radiant energy derived from the sun into electrical energy, or through electrical energy into mechanical energy. I may directly employ the electrical energy so obtained, or I may convert it into mechanical energy prior to such utilization.

In order to carry my improvement in the aforesaid art into practical effect, I concentrate or converge the solar beam upon any electro-generative apparatus which depends upon an increase of its temperature for the production of an electric current, or, in other words, which will yield electrical energy in a proportion to the increase of temperatures to which it is subjected. A thermo-electric element wherein two bodies of dissimilar metal are placed side by side united at one end, and everywhere else insulated from one another, is such an electro-generative apparatus. When several of such elements are joined in series, so that their alternate junctions lie near together and in one plane, such an arrangement is termed a "thermopile." If one junction of a thermo-electric element or one set of junctions in a thermopile be heated to a fixed temperature, and the other junction or set of junctions be maintained at a lower temperature, then an electrical current will be set up in a circuit including said dissimilar metal bodies, the electro-motive force of which current in the thermopile will be the sum of the electro-motive forces of the currents produced by the several elements and will increase up to a maximum proportionately to the increase of temperature. I expose to the solar rays one set of the junctions of a thermopile. I thus cause an electrical current in a circuit including said thermopile. Inasmuch, however, as for practical purposes it is not expedient to construct the face of a thermopile of very large area, I concentrate the solar beam upon the face of the thermopile by any known device for that purpose—such as converging mirror or lens—so that relatively much higher temperature, and hence greater energy per unit of surface area, may be obtained.

In order, further, to produce absorption of both heat and light energy, I cover the face of the thermopile with any absorbent material—such as lamp black—or I may simply dull such surface, so that its capacity for reflecting light rays may be diminished as far as possible. The electrical current thus obtained I may accumulate in a storage or secondary battery; or I may conduct it directly to any form of electromotor wherein the electrical energy of said current is converted into mechanical energy.

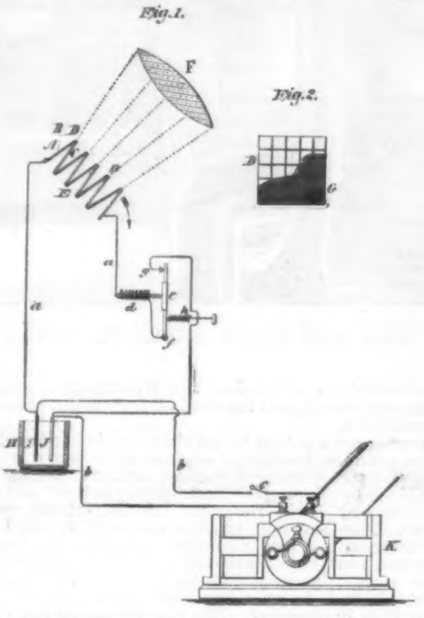
In place of a thermopile I may employ any equivalent means for converting heat energy into electrical energy. So, also, as already stated, I may employ various means for converging or concentrating the solar rays upon the electro-generative apparatus.

One mode of carrying my invention into practical effect is embodied in the apparatus illustrated in the accompanying electrical diagram, which, it will be understood, does not show exact proportions or details of construction.

In the accompanying drawings, Fig. 1 is a general diagrammatic view of an apparatus embodying my invention. Fig. 2 represents the heat-receiving surface of the thermopile in plan view.

A represents a thermopile composed of bars, B C, of dissimilar metals, joined at D and E.

Fig. 1. Fig. 2.



EDWARD WESTON'S APPARATUS FOR UTILIZING SOLAR RADIANT ENERGY.

F is a lens whereby the solar rays are concentrated or converged upon the surface formed by the junctions, D, of said pile. Said surface may be covered with a light-absorbing material, G, as lamp black, substantially as indicated in Fig. 2, where a portion of said covering is represented as broken away, or be simply dulled or darkened, so as not to reflect light rays.

The thermopile, A, is connected by wires, *a a*, in circuit with the electrodes, I J, of the secondary cell, H, and said electrodes are also connected by wires, *b b*, with the binding posts of any form of electromotor, as K. Interposed in one of the wires, *b*, is an ordinary circuit closer, *c*, whereby circuit can be established or broken between the secondary cell, H, and motor, K.

At *d* is an electro-magnet having its coil in circuit with one of the wires, *a*. The armature, *e*, of said magnet is polarized. Said armature is pivoted at *f*, and is connected to one terminal of the magnet coil, so that the circuit proceeds from the coil through the armature to a stop, *g*, wherewith the armature makes contact when attracted by the electro-magnet, and thence to the secondary cell, H. A spiral spring, *h*, attached to the pivoted armature, aids in retracting the same from the pole of the magnet.

When the current proceeds from the thermopile to the secondary cell, the magnet and the polarized armature mutually attract, and circuit to the secondary cell is maintained. When, however, the strength of the current in the cell becomes greater than that passing to the cell, then the magnet poles are reversed, and magnet and armature mutually repel, and circuit between cell and thermopile is broken. In this way short-circuiting of the cell through the thermopile may be prevented. This arrangement of automatic circuit closer I do not claim. I introduce it here merely as illustrative of known apparatus practically useful for the purpose stated.

The object of the storage or secondary cell is to accumulate the solar radiant energy in the form of electrical energy, so that, for example, energy accumulated during hours of sunshine may be utilized during night or periods of cloudy weather; or, in other words, said cell here acts substantially as a reservoir into which electrical energy may be intermittently delivered, but from which it may be taken as a constant supply.

I am well aware that various devices have been contrived for directly utilizing solar heat to produce steam or hot air, or for measuring the intensity of solar radiation; but I am not aware that the utilization of the sun's heat and light rays through the conversion of solar radiant energy into electrical energy or into mechanical energy through intermediate conversion into electrical energy has hitherto been accomplished.

THE ELECTRIC LIGHTHOUSE AT THE SCANDINAVIAN EXHIBITION, COPENHAGEN.

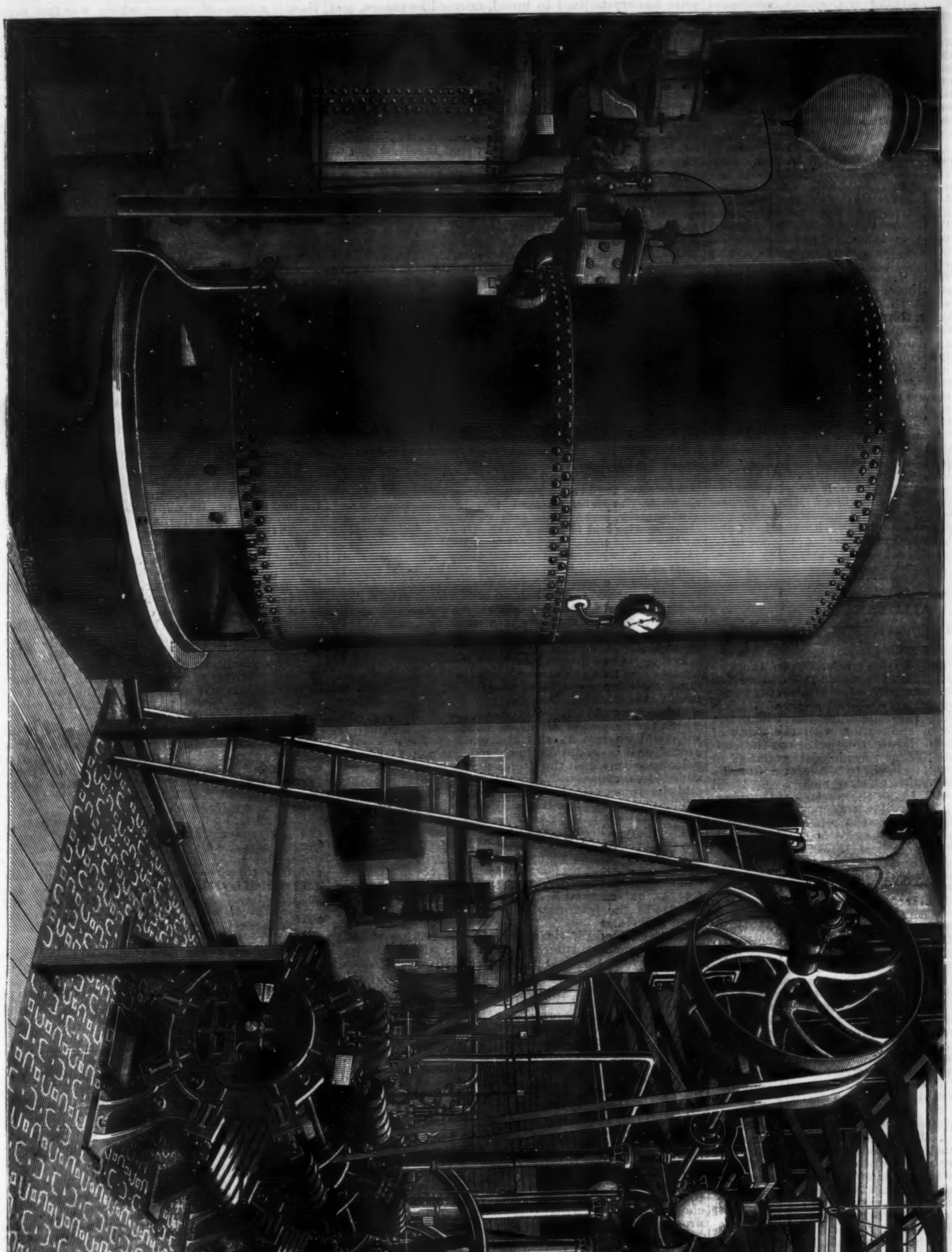
Any visitor to the Scandinavian Exhibition will have been struck with the remarkable electric lighthouse and its machinery, destined for the Hanstholm, on the west coast of Jutland. This light is about two million candle power, the greatest in the whole of Europe, its range being about twenty-six miles. With the light is combined a station for powerful foghorns, or roarers, worked by compressed air. The light is, in the exhibition, placed on an improvised low tower, built of soft limestone, but the tower on the Hanstholm is over 200 ft. above the sea level. At the foot of the tower there is the building containing the electric and pneumatic machinery for the light and for the foghorn. The light has been kept burning every evening since the latter part of August, and the powerful flashes or rays revolving in the sky afford a remarkable sight. The foghorn was not sounded, for fear of the tremendous roar annoying the inhabitants of Copenhagen in general, and the visitors to the exhibition more especially.

The arrangement of the machinery will be understood from the illustration and from the following particulars. The lighthouse on its small tower erected in an open part of the exhibition is also shown, but the real tower on the Hanstholm is, as stated, much higher. For producing the electricity for the light are employed two De Meritens' magneto-electric alternating current machines of the G type, as used for the French lighthouses. These are driven by two compound steam engines of 35 horse power. These engines also drive an air compresser for supplying the foghorns with compressed air. Each armature consists of five rings, with copper wire coiled thereon, each ring being divided in sixteen bobbins. The five rings are fixed equidistantly vertically on a shaft. Outside the rings there are bundles of horseshoe magnets, eight bundles for each ring, and each magnet bundle consisting of two plates. Of the sixteen bobbins on a ring, four are connected in series and four in parallel. Half the machine is further connected in parallel, and the conductor led to the collector rings on the shaft, whence the current through brushes and conductors from each half machine leads to the switch board. The latter consists of a wooden board, to the back of which are fixed two vertical brass bars, which are connected to the couplers, and on front are fixed two horizontal brass bars, to which the conductors from the bushes are carried. Where the bars intersect there are screw holes, so that by the means of screws the front bars may be electrically connected with the back bars, and thus connect half, one, one and a half, or two machines in arc with the couplers. The armature makes normally 850 revolutions per minute. The circuit includes an arc lamp. The E.M.F. is 42 volts and the amperes 50 to 200, according to the dimensions of the carbons in the lamps, and that part of the machine which is connected.

The arc lamp—Le Baron's—is self-regulating by clockwork, with pawl and pawl wheel. The pawl is acted upon by an electromagnet, the coils of which are included in parallel arc with the lamp circuit. When the distance between the carbons becomes great, a comparatively small amount of current passes through the electromagnet, so that the pawl against the action of a spring is attracted, and the clockwork is set going, and the carbons are made to approach to each other, but so that the center of light always remains at the same height. Another electromagnet is arranged for starting the lamp. At the moment of putting the lamp in the circuit the carbons are apart, wherefore the current will pass through the pawl electromagnet, move the pawl, and thus close the circuit in the other electromagnet, the keeper of which lifts the bottom carbon so as to touch the top carbon; but the same moment the current through the pawl electromagnet will be weakened, so that the pawl is drawn back by its spring and the circuit broken in the other electromagnet. The bottom carbon drops again, and the proper distance is obtained. The pawl spring can be adjusted by a screw, whereby the lamp is made to burn with larger or smaller arc; and by another screw both the carbons can be moved simultaneously to bring the arc in the focus of the lantern. The regulation is effected from the watch room by suitable rods and bevel wheel gear connected to the regulating screws. By means of a prism a picture of the arc is thrown through a hole in the lantern floor upon a mirror in the watch room, so that the attendant may observe when the lamp needs regulating. He need, therefore, not go up to the lantern except when the lamp has to be changed. This is done by sliding the lamp on rails back upon a movable bridge and pushing the lamp at right angles to the rails until another lamp that stands on the bridge comes opposite the rails. The other lamp is then pushed into its place.

The optical lens apparatus is 1·82 meter in diameter and three meters high, of Barbier & Co.'s make, of Paris. It consists of thirty partitions and 1,470 pieces of glass, and is rotated by clockwork.

Two foghorns are to be erected at the Hanstholm; but as the lighthouse lies a little way from the coast, and the foghorns should be as near the sea as possible, they are placed 3,000 ft. and 1,800 ft. respectively from the lighthouse, and the compressed air is pumped by the compressor through pipes into air vessels at the foghorn stations. Each station has two such vessels, a large and a small one, connected by a pipe with reducing valve to keep a constant pressure in the small air vessel of about four atmospheres, while the pressure is greater in the large vessel. The air from the small vessel is led to the foghorn, when a stop valve is opened and the foghorn sounded. The steam engines, air compressors, and air vessels have been made by the Danish company, Helsingør's Jernskibs and Maskinbyggeri. The air compressors are placed between the engines, so that the crank shafts are in continuation of each other, and the pumps and engines are connected by disconnectable friction clutches. The air can be compressed into the large air vessels to six or seven atmospheres, and kept at that while the foghorn is sounded. But when it is not in operation the pressure rises to twelve atmospheres, which store of pressure is sufficient to keep the foghorn going for about three-quarters of an hour without lowering the pressure in the large air vessel below four atmospheres, and meanwhile the engines can be started for a fresh supply of compressed air. By this arrangement the advantage is obtained that the foghorn may be started at a moment's notice, when



MACHINERY OF THE ELECTRIC LIGHTHOUSE, THE HANSTHOLM, JUTLAND.

MR. FLEISCHER, COPENHAGEN, ENGINEER.

a fog suddenly sets in, a thing of frequent occurrence on that coast, and the foghorn can be kept in operation while the fog lasts. But as the available power is only enough to compress to seven atmospheres, a third large air vessel is provided in the engine room, and to get this charged to twelve atmospheres pressure, one of the pumps charges this vessel up to seven atmospheres, and the suction valves of the other pump draw their supply from this vessel and compress the air in the large air vessel at the foghorn station to twelve atmospheres.

These foghorns are intended to give three roars in quick succession every other minute; hence the stop valve between the small air vessel and the foghorn has to be opened at these regular intervals, which is done automatically by clockwork. But it is also desirable to be able to sound the foghorn from the lighthouse without special attendants therefor at the foghorn station. A small motor is therefore provided in the engine room, which drives a small dynamo, the circuit of which is connected with an electromagnet at the foghorn station. When the current is made to flow, the keeper of this electromagnet is attracted, whereby the admission valve to the foghorn is opened. The clockwork is included in that circuit for the purpose of closing it at the intervals named. Should this electromagnetic opening appliance fail, another clockwork is provided at the foghorn station which can influence the electromagnet directly, but can only be put into action at the foghorn station.

There is in the engine room a mirror, having a surface of such a nature that all the light rays proceeding from the lamp, which fall into the mirror, are reflected parallel with a horizontal plane intersecting a vertical line. The mirror will therefore illuminate a horizontal angle with the upper point of the collecting line. By inserting colored glass, various parts of the angle become colored. This mirror, which is constructed by the Danish chief lighthouse engineer, Mr. Fleischer, may be suitably used for illuminating narrow channels or inlets. The construction and workmanship of the whole of the apparatus and machinery appeared to be of the highest order, and all works remarkably well.—*The Engineer.*

[Continued from SUPPLEMENT, No. 675, page 10787.]

ALLOYS.*

By Professor W. CHANDLER ROBERTS-AUSTEN, F.R.S.

LECTURE II.

THE last lecture ended with a reference to the evidence which led Matthiessen to conclude that in certain cases the union of metals with each other must be attended with their passage into allotropic states. This is probably the most important generalization which has hitherto been made in connection with the study of alloys, and I propose to devote this lecture to the consideration of this question of the molecular change in metals. It may be well to begin by a reference to some early views as to the constitution of metals, and I will ask you, therefore, to look at the surface of this mass of antimony which is adorned with a large crystalline star. An attempt to explain the origin of the star arose from a very early investigation into the structure of metals, and drew from Robert Boyle, in 1663, a protest against the supposition that "a certain respect to times and constellations is requisite to the production of this admirable body," as he called it. (Opera, ed. 1772, vol. i., p. 325.) Lemery, a little later, in 1675 ("A Course of Chemistry," English ed., 1686, p. 212), pointed out that "the star which appears upon antimony when it is well purified has given occasion to chymists to reason upon matter. The greatest part of these men being strongly persuaded of the planetary influences, have not wanted to assert that this same star proceeded from the impression which certain little bodies flowing from the planet Mars do bestow upon antimony for the sake of the remaining iron that was mixed with it, and for this reason they wonderfully recommend the making of this preparation upon Tuesday rather than another day, between seven and eight o'clock in the morning, . . . provided the weather be clear and fair." He adds: "My thoughts . . . shall not soar so high as these men's do; . . . I shall not search the celestial bodies for an explication of the star we now contend about, seeing that I can find it in causes near at hand. . . . I say, then, that the star doth proceed from the antimony itself; the purification of the metal does serve to lay open the crystals of antimony, and the iron (it contains) by its hardness does expatiate these crystals." This attempt of Lemery to explain the development of a crystalline structure in a metal by the influence which the presence of a small quantity of a metallic impurity exerts will serve as a fitting introduction to the class of facts I want to bring before you to-night, the study of which has been much neglected, notwithstanding their importance in metallurgical industry.

All I can do is set before you some evidence which may serve to throw light upon the question why a definite material actually employed in the manufacture of, say, a bridge or a weapon, can be depended upon to perform the duty intrusted to it, and why a certain other material would be absolutely untrustworthy, although chemical analysis can barely show the difference between the two. It has long been known that the properties of a metal may be influenced by the presence of a minute quantity of another element, even though it is so small as to preclude the possibility of its action being due to the formation of an ordinary chemical compound to which any reasonable formula, based upon atomic proportions, could be assigned.

It by no means follows, however, that the atom of the added element does not exert a direct influence, or that its action is not controlled by a well known law, but it is clear that in the experiment I am about to make, for instance, we are not dealing with the union of elements in atomic proportions. Here are two ladles containing exceptionally pure bismuth; they have been, as you see, filled from the same crucible containing the molten metal, and into one ladle I will introduce this tiny fragment of tellurium suspended above the molten mass of metal in one ladle. The contents of both ladles will be poured into moulds, and when the metal is cold it will be fractured. You will see that the bismuth to which the tellurium is added has become minutely crystalline, while that which remains pure has crystallized in broad, mirror-like planes, and one reflects a ray of light like a mirror, while the one containing the tellurium scatters the light.

If we had no other guide than that afforded by mere inspection, you would say that the two masses were totally distinct elemental substances, and yet the only difference is that one contains $\frac{1}{1000}$ part of tellurium, and the other does not.

There are many such facts to be met with in practical metallurgy, and the knowledge of them has been steadily accumulating for centuries, but it is only since the end of the last century that it can be said to have been built up on a scientific basis, for it was not until 1781 that Bergmann discovered the wonderful fact that the difference between wrought iron and steel depends upon the presence or absence of a small quantity of carbon. The smallness of the amount of carbon capable of producing such striking effects greatly astonished him and the chemists who followed him and repeated his experiments, but, strange as it may seem, the promulgation, in 1803, of Dalton's atomic theory threw a flood of light upon chemical phenomena, but cast into shade such investigations as those of Bergmann, which dealt with influences of traces upon masses, and the authority of Berthollet was not sufficient to save them from neglect. In this eventful year for science, 1803, the latter published his essay on chemical statics, in which he stated, as a fundamental proposition, that in comparing the action of bodies on each other, which depends "upon their affinities and mutual proportions, the mass of each has to be considered."* His views were successfully contested by Proust, but, as Lothar Meyer says, the influence on chemistry of the rejection of Berthollet's views was remarkable. "All phenomena which could not be attributed to fixed atomic proportions were set aside as not truly chemical, and were neglected. Thus chemists forsook the bridge by which Berthollet had sought to unite the sister sciences, physics and chemistry." Fortunately, however, in this country there was one chemist who had followed up the line of work indicated by the early metallurgists, for in 1803, the same year as that in which Berthollet's essay was published, Charles Hatchett† communicated to the Royal Society the results of a research which he had conducted, with the assistance of Cavendish, in order to ascertain "the chemical effects produced on gold by different metallic substances when employed in certain" (often very small) "proportions as alloys." I shall subsequently refer to Hatchett's work.

Before we can investigate the nature of the action of traces of an element on masses of other elements, we must consider some facts bearing on the relation between atoms and molecules. Let these glass spheres which are spread out before you represent the atoms of which the molecules of an element are composed. If we could change at will the mass of the individual atoms, or if we could diminish or increase at will the velocity with which the atoms move, it might be possible to transmute one elemental substance into another, and the object of the alchemist would be realized.‡

The progress of research may show that it is possible, by a sufficiently high temperature, or by a suitable application of heat, to modify the number or form of the atoms into which the molecule is split up, and in this way to resolve one elemental substance into another; at present we only know with certainty that we can change the grouping of the atoms in a molecule, but cannot alter the atoms themselves. That such change in the grouping of atoms is possible has long been known.

Berzelius made it clear that bodies having exactly the same chemical composition possess widely different chemical and physical properties. Here is a mass of black sulphide of mercury, here the red sulphide. Chemical analysis shows no difference between them, and yet their aspect is widely different.

Many similar cases present themselves in the range of organic compounds, as Dr. Tidy has reminded us by a reference to narcotine and peperine, the former being the very substance to send you to sleep and the latter to keep you awake, notwithstanding that composition is identical, although the grouping is different. To such bodies as the red and black sulphides of mercury the term isomeric is applied.

It is now, I think, recognized that, except in the case of unstable forms of elements, the occurrence of elements in different allotropic states means that, in the respective cases, the atoms are differently arranged in the molecules of which the body is composed. I need not dwell upon these definitions here; all I want to insist upon is the great industrial importance of the change in the molecular conditions of metals and alloys produced, as these changes are, by comparatively slight influences.

It may help us to remember the importance of the subject if we bear in mind that the moral significance of allotropy, or rather of isomerism, has been recognized by one of the most subtile and refined writers of modern times, for the "Strange Case," related by Mr. R. L. Stevenson, shows us what might happen if the same human being revealed alternately two entirely different natures and attributes. I have not hesitated to refer to this, because certain metals may, under slight influences, be made to assume forms in which, as regards special service required from them, they behave either usefully or entirely prejudicially.

With regard to metals, chemists have, even to present day, been very slow to examine the conditions under which a metal, when pure, can exhibit widely different properties—can pass from one allotropic state, as it is termed, to another. Berzelius claimed that the metals osmium and iridium could exist in different allotropic states; and in 1846 Joule and Lyon Playfair§ showed that certain metals in different allotropic states possessed different volumes; and although chemical analysis could detect no change in the composition of a particular metal in either of its different states, its properties were widely different. I have here several instances of this. In 1849, Bolley taught us to prepare lead in this form by electrolysis. It is as pure as this piece of sheet lead; but Bolley's lead oxidizes rapidly in air, and becomes converted into a yellow powder, and sheet lead, we know, does not. Here is a form of copper which was first prepared in 1878 by Schutzenberger; its specific gravity is less than that of ordinary copper, it oxidizes rapidly in air; its behavior in relation to nitric acid is different from that of ordinary copper; and last, it may be converted into ordinary copper by prolonged contact with dilute sulphuric acid.

Similar cases of allotropism are claimed by Fritsche for tin, and for silver by Schutzenberger.* I have not specially alluded to Gore's antimony, or to modifications of nickel and palladium, because in their cases the passage from one state to another is determined by the presence or absence of occluded gas, and therefore the phenomenon becomes more complicated than when the composition of the metal is unchanged. It is quite true that in the cases I have referred to, the variations in properties—the allotropy of the same element—are far less marked than the variations which characterize isomerism of organic compounds; but they are, nevertheless, very real and important, and if we knew the metals I have mentioned only in their unstable conditions, they would be unfit for industrial use. Imagine a vessel sheathed with Schutzenberger's copper, or a cistern lined with Bolley's lead—disintegration and disaster would rapidly ensue in either case.

Fritsche found that certain ingots of tin, when exposed to the rigor of a Russian winter, fell into powder. This powder was certainly an allotropic form of tin; it was gray and needle-like, but, by heating to a point far below its melting point, it became changed into ordinary tin; and Fritsche points out that this property which tin possesses of passing into an unusual condition led on one occasion to some difficulty. A quantity of buttons, consisting mainly of tin, and intended for the adorment of military uniforms, were safely delivered by the manufacturer and placed in store. On inspection, however, by the military authorities nothing but a shapeless mass of gray powder remained, for the tin had assumed its allotropic form, and the buttons disappeared. Specimens of such tin I have seen, but I regret that I have not been able to obtain a fragment.

We may now consider the question, Do metals, when they enter into union with each other, preserve their normal conditions, or do they in any case assume allotropic states? The experimental evidence that they do is somewhat difficult to obtain, but I will endeavor to set some facts before you.

Joule proved that when iron is released from its amalgam by distilling away the mercury, the metallic iron takes fire on exposure to air, and is therefore clearly different from ordinary iron, and is, in fact, an allotropic form of iron. Moissan† has shown that similar effects are produced in the case of chromium and manganese, cobalt and nickel, when released from their amalgams with mercury.

Evidence is not wanting of allotropy in metals released from solid alloys, as well as from fluid amalgams with mercury. Certain alloys may be viewed as solidified solutions, and when such bodies are treated with a suitable solvent, usually an acid, it often happens that one constituent metal is dissolved, and the other released in an insoluble form. Here is a new alloy of potassium and gold, containing about ten per cent. of the precious metal. If a fragment of this alloy be thrown upon water, the potassium takes fire, decomposes the water, and the gold is released as a black powder; there is a form of this black or dark brown gold which is, I believe, an allotropic modification of gold, as there is evidence that it combines with water to form auric hydride. By heating this dark gold to dull redness, it at once assumes the ordinary golden color.

The Japanese use this gold, released from gold-copper alloys, in a remarkable way (Fig. 8), for they produce, by the aid of certain pickling solutions, a beautiful patina on copper which contains only two per cent. of gold, while even a trace of the latter metal is sufficient to alter the tint of the patina.

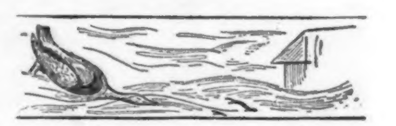


FIG. 8.

The diagram represents a portion of a Japanese knife handle in the collection of Mr. Marcus B. Huish. It consists of *Shi-bu-ichi*, an alloy containing about equal parts of silver and copper. The duck is of *Shakudo*, the alloy of copper with from one to five per cent. of gold. By "pickling," a gray patina is given to the *Shibuichi*, and a purple patina to the *Shakudo* duck, the arrangement being so skillful that the neck of the duck appears to be beneath the water, and is only seen when the handle is held toward the light in certain directions.

The best illustration I know of the change produced in a metal by the action of mercury is afforded by the following experiment, for which I am indebted to Mr. Laurie, to whose work in another direction I referred in the last lecture. This plate of metallic aluminum would, as you know, long remain exposed to air without sensible oxidation. Mercury also does not oxidize at the ordinary temperature, when exposed to air, but if the surface of this plate be covered with a layer of mercury, then oxidation rapidly ensues, and the plate will soon become covered with a white film of alumina, which may be detached in flakes. Clearly, the condition of the aluminum has been modified by its union with the mercury.

You will remember that in the last lecture we saw that water could be frozen by the solution of finely divided fusible metal in mercury. It is not a matter of indifference whether the powders of the mixed constituents of the alloy are employed, or whether the alloy is previously prepared by fusion, and then powdered, which shows that the act of fusion has effected some change in the molecular arrangement of the metals, a point I am investigating, hitherto with somewhat conflicting results. The explanation of the depolymerization of metals, when they are united with each other, is somewhat complicated, but I will attempt it with as much brevity as possible. First, Mazzetto‡ has shown that there is a similar lowering of temperature, though to a far less extent, when molten

* Three lectures delivered before the Society of Arts, London, 1888. From the *Journal* of the Society.

* English Edition (by M. Farrell, M.D.), 1804, p. 5.

† "Phil. Trans.," vol. 93, p. 43, 1803.

‡ Consult also Kopp, "Die Alchemie in alterer und neuerer Zeit," vol. ii., 1886, pp. 174-178.

§ "Memoirs of the Chem. Soc.," vol., iii., p. 57.

* "Bull. Soc. Chim., Paris," t. xxx., 1878, p. 3.

† "Comptes Rendus," t. lxxxviii., p. 180, 1879.

‡ "Rendiconti del R. Instituto Lombardo" (2), vol. xviii., No. 3.

tin is mixed with molten lead, so that the lowering of the temperature is by no means confined to the solution of metals in mercury. The next step we owe to Professor W. Spring, of Liege, whose results in building up alloys by compressing the powders of their constituent metals I showed you in the last lecture. Spring finds that by determining the amount of heat given out by alloys of lead and tin on cooling from a molten state, more heat is actually given out than might be expected from the results of calculation.* The difference is so great that it could not be due to errors of observation, for in actual numbers it amounts to many hundreds of calories for a weight of 100 grammes. He concludes that when molten tin is added to molten lead, the atomic constitution of the molecules is simplified, that is, depolymerization takes place. Let it be assumed that each molecule of molten lead contains an arbitrary number of atoms, say five atoms, and that the molecule of molten tin also contains five atoms. If one molecule of lead be added to three molecules of tin, so as to form the alloy $PbSn_3$, five groups of $PbSn_3$ will be the result, but each molecule of the alloy will contain four atoms instead of five, as this diagrammatic model shows. This molecular change, which I have effected by pulling the atoms asunder, requires heat to do the work of rearrangement in the molten admixture of metals, and as this heat is absorbed, cold is produced, and it will, therefore, be evident that both theory and experiment lead to the view of molecular change produced by alloying metals.

[The nature of the molecular change resulting in the absorption of heat which attends the admixture of molten lead and tin, and the evolution of heat which is observed when alloys of these metals solidify, was demonstrated to the audience by means of diagrams and models which it would be difficult to describe here. The reader is, therefore, referred to Professor Spring's paper, cited above. The subject is complicated by the possibility of chemical combination in the case of certain alloys such as $PbSn_3$.]

Debray† has given us a case of an alloy in which a simple elevation of temperature induces allotropic change in the constituent metals. It is prepared as follows: Ninety-five parts of zinc are alloyed by fusion with five parts of rhodium, and the alloy is treated with hydrochloric acid, which dissolves away the bulk of the zinc, leaving a rich rhodium zinc alloy, containing about 80 per cent. of rhodium. When this alloy is heated in vacuo to a temperature of 400 deg. C., a slight explosion takes place, but no gas is evolved, and the alloy is then insoluble in *aqua regia*, which dissolved it readily before the elevation of temperature caused it to change its state. We are thus presented with another undoubted case of isomerism in alloys, the unstable, soluble modification of the alloy being capable of passing into the insoluble form by a comparatively slight elevation of temperature. [Experiment shown.]

We have seen allotropic states produced in metals by their release from their amalgams, and from alloys with each other, and I have given you evidence of polymerization induced by the act of alloying metals. We have just examined a case in which simple elevation of temperature is sufficient to cause molecular change in an alloy. There is, therefore, firm experimental basis for the view to which Matthiessen was guided, nearly thirty years ago, by a study of the electrical resistance of solid alloys, that when metals are united to form alloys, in many cases one metal, and sometimes both metals, assume the allotropic state. He showed, for instance, that silver has a conductivity represented by 100. The addition of a small quantity of gold to the silver is attended with a rapid fall in the conducting power. The conductivity of pure copper may be represented by the number 98. The addition of a small portion of tin greatly diminishes the conductivity, as is proved by the curves given in the last lecture. He points out that the amount of tin is too small to admit of the possibility of a chemical compound being formed, and from this fact and other evidence he concludes that the passage to an allotropic state can alone explain the result. This leads me to speak of the influence of small quantities of one element on large masses of another. You may say, Does it matter, after all? Grant that a metal may assume an allotropic state in virtue of the presence of a small quantity of foreign matter hidden in it. Is the mass any the worse or better, are its physical or mechanical properties greatly modified? Submarine telegraphy will present us with the first case. It may sound strange, but the commercial success of a submarine cable is measured by the speed with which messages can be sent through it, and upon this point we have the testimony of Mr. Preece, who tells us that a cable made of the copper of to-day, when the necessity for employing pure copper is recognized, will carry twice the number of messages that a similar cable of less pure copper would, in 1858, when the influence of impurities in increasing the electrical resistance of copper was not understood. A paper by Sir W. Thomson‡ shows how important the purity of copper is, and how obscure is the mode of action of the impurity. I believe it is safe to say that the presence of one-tenth per cent. of bismuth in the copper would, by reducing its conductivity, be fatal to the commercial success of the cable.

The influence of small quantities of foreign matter is more marked in the case of iron. Steel differs from iron, as you know, by containing a small quantity of carbon. If you introduce into the iron two-tenths per cent. by weight of carbon, you produce a material which would make an excellent bridge or a boiler plate, but if fashioned into a weapon would be absolutely untrustworthy, for it would bend, as this worthless sword did, when very moderate demands were made upon it. On the other hand, if you introduce eight-tenths per cent. of carbon, you obtain a material from which a good razor might be made, but it would be useless for a rail or for the construction of a bridge.

I will now appeal to gold. The addition of two-tenths per cent. by weight of bismuth would, from the point of view of coinage, convert the gold into a useless material, which would crumble under the pressure exerted through the die. Instances of a similar nature might be multiplied indefinitely. I will only quote a statement of Sir Hussey Vivian, who says that one one-thousandth part of antimony will convert best select copper into the worst conceivable. Here is a sample of the alloy called "yellow metal," which would certainly have been condemned, because its fracture affords evidence of the presence of the one ten-thousandth part of antimony, which is found to prejudice the working properties of the alloy.

* "Bull. de l'Acad. Roy. de Belgique" (3), t. xi., No. 5, 1886.

† "Comptes Rendus," xc., 1880, 1195.

‡ "Proc. Roy. Soc.," vol. x., p. 301, 1860.

Is it possible to explain facts such as these? We have seen that comparatively slight variations in external conditions can affect the atomic arrangement of metals, and we must now ascertain what relations may subsist between the atoms of the mass of metal and the atoms of the added impurity. First, as regards the cohesion of a metal, this property may be investigated by the aid of heat, or by submitting the metal to mechanical stress, and in a research to which I have devoted much time I selected tenacity as the property to be tested, with a view to ascertain the effect of the added matter upon a metal or alloy when an attempt is made to pull the metal asunder in an ordinary testing machine.* Gold was chosen as the subject of the experiment for the following reasons: First, it is a metal which it is possible to purify in a very high degree, it is not liable to oxidation, and the accuracy of the results is not affected by the presence of occluded gases. The purest gold has a tenacity of seven tons to the square inch, and it elongates about twenty-five per cent. before breaking. Standard gold, which contains over ninety-one per cent. of gold, the alloying metal being copper, has a tensile strength of eighteen tons per square inch, and it stretches thirty per cent. before breaking. In fact, when an eminent engineer saw the results of these tests, he expressed an opinion as to the possibility of making a very good gun of standard gold if the cost of the material were no object. When, however, a small quantity of certain metals, $\frac{1}{100}$, $\frac{1}{10}$, or $\frac{2}{10}$ per cent., be added to the gold, the cohesion of the metal is reduced in a very remarkable way, as Hatchett showed to be the case in 1803. This bar contains 100 sovereigns melted with $\frac{1}{10}$ per cent. of lead; you see that its cohesion is reduced to a very low point, for it is as brittle as can be. I have tried the effect of adding to pure gold other metals and metalloids than lead, introducing in each case as nearly $\frac{2}{10}$ per cent. of the purity as possible. Some of these elements reduced the tenacity and extensibility of gold to a very low point, while others increased one or both of these properties. I will now attempt to give an explanation of these facts. Since 1826, when Gmelin called attention to the relations between the atomic weight of elements which have similar properties, chemists have been actively engaged in establishing analogies between the properties of the elements and in arranging them systematically, and the result has been (mainly through the labors of Newlands, Mendeléef, and Lothar Meyer) the promulgation of the periodic law. This law states that the properties of the elements are a periodic function of their atomic weights. Lothar Meyer has gone further, and has shown that a remarkable relation exists between the atomic volumes of the elements. Now, however tiny the atoms may be, they must possess volume, and the volume of each element will be peculiar to itself. The space occupied by the atomic volume cannot be measured absolutely, but relative measurements may be obtained "by taking such quantities of the elements as are proportional to their atomic weights, and comparing the space occupied by these quantities." The relative atomic volumes of the elements are found by dividing the atomic weights of the elements by their specific gravities. The atomic weight of gold is 196·2; $\frac{196·2}{19·3} = 10·2$ the atomic volume, or, expressed in the metric system, 196·2 grms. of gold would occupy a space of 10·2 cubic centimeters. Lead, on the other hand, would have the large atomic volume of 18·1, and potassium that of 45·1. The question now arises, Does the power to produce fragility, which we have seen certain elements to possess, correspond to any other property of metals with which they may be classified? The facts represented in the periodic law were, in 1869, graphically represented by Lothar Meyer in his well known curve of the elements. By adopting atomic weights and atomic volumes as co-ordinates, he showed that the elements can be arranged in a curve representing a series of loops, the highest points of which are occupied by cæsium, rubidium, potassium, sodium, and lithium, while the metals which are most useful for industrial purposes occupy the lower portions of the several loops.

An examination of the results I have hitherto obtained shows that not a single metal or metalloid which occupies a position at the base of either of the loops of Lothar Meyer's curve diminishes the tenacity of gold. On the other hand, the fact is clearly brought out that metals which render gold fragile all occupy high positions on the curve. This would appear to show that there is some relation between the influence exerted by the metallic and other impurities and either their atomic weights or their atomic volumes. It seems hardly probable that it is due to atomic weight, because copper, with an atomic weight of 63·2, has nearly the same influence on the tenacity of pure gold as rhodium, with an atomic weight of 104, or as aluminum, the atomic weight of which is 27. It will be evident from the table below, which embodies the results of my experiments, that metals which diminish the tenacity and extensibility of gold have high atomic volumes, while those which increase these properties have either the same atomic value as gold or a lower one. Further, silver has the same atomic value as gold, 10·2, and its presence in small quantities has very little influence one way or the other on the tenacity or extensibility of gold.

Several of the elements, the action of which has been examined, occupy somewhat abnormal positions, and the reason for this remains to be explained. I hesitate to attempt to offer any mechanical theory to account for the action of the elements, but it may perhaps be well to refer to these spheres, as affording a rough indication of what may take place. If five spheres, representing atoms of a certain volume, are arranged so as to touch each other, it will be evident that the addition of an element with a small atomic volume may improve the tenacity by filling up the central space which would otherwise remain void; with such an arrangement of five atoms the addition of an element with the same atomic volume as themselves will tend to drive them slightly further asunder, and should, therefore, act prejudicially in a five-atom group, although it would exactly fill the space between a six-atom group, but in either case the insertion of a larger atomic volume than that of each member of the group must tend to drive the members of either the five- or six-atom group further asunder, and by so doing would diminish the cohesion of the mass. No doubt, in some cases, condensation takes place, and this may explain some of the abnormal results.

* "Proc. Roy. Soc.," vol xliii., p. 425, 1888.

Name of added Element.	Tensile Strength. Tons per Square Inch.	Elongation, per cent. (on three inches.)	Impurity per cent.	Atomic volume of Impurity.
Potassium	Less than 0·5	Not perceptible	Less than 0·2	45·1
Bismuth	0·5 (about)	"	0·210	20·9
Tellurium	3·88	"	0·186	20·5
Lead	4·17	4·9	0·240	18·0
Thallium	6·21	8·6	0·193	17·2
Tin	6·21	12·3	0·196	16·2
Antimony	6·0 (about)	qy.	0·203	17·9
Cadmium	6·88	44·0	0·202	12·9
Silver	7·10	33·3	0·200	10·1
Palladium	7·10	32·6	0·205	9·4
Zinc	7·54	28·4	0·205	9·1
Rhodium	7·76	25·0	0·21 (about)	8·4
Manganese	7·99	29·7	0·207	6·8
Indium	7·99	26·5	0·290	15·3
Copper	8·22	43·5	0·193	7·0
Lithium	8·87	21·0	0·201	11·8
Aluminum	8·87	25·5	0·186	10·6

Questions of great industrial interest present themselves, especially in connection with iron. With regard to this metal, the evidence as to the action of other elements upon it would appear to tend in the same direction as in the case of gold, although the question is greatly complicated by the relations of iron to oxygen and by the presence of occluded gases. It may be sufficient for the present to point out that the atomic volume of iron is 7; carbon, the atomic volume of which is small, when present in quantities varying from 0·2 to 1 per cent., improves its tenacity. Silicon, notwithstanding its large atomic volume (11·1), appears to improve the tenacity of iron, although little is as yet known concerning its influence in small quantities. Sulphur and phosphorus, on the other hand, have the large atomic volumes of 15·4 and 14·8 respectively, and both these elements have, as is well known, a highly prejudicial effect on the qualities of iron. Take the case of arsenic, which has an atomic volume of 13·3. One of my own students, Mr. Harbord, has recently read a paper before the Iron and Steel Institute, in which he shows that the effect of the presence of $\frac{2}{10}$ per cent. of arsenic is very prejudicial to iron.

We do not as yet know what is the effect of manganese on absolutely pure iron, but in the simultaneous presence of carbon its influence is most remarkable. You cannot make a magnet out of iron which contains a certain amount of manganese. Its atomic volume is the same as that of iron, and therefore it ought not to act prejudicially on the tenacity of iron, and I think I am safe in saying that it does not. But with regard to permeability of iron to magnetism, the manganese has a remarkable effect, for, as Dr. Hopkinson tells us, "manganese enters into that which must be regarded for magnetic purposes as the molecule of iron, and annihilates the magnetic properties of iron."* I could have wished for no better evidence as to molecular change in a metal.

Take again the capacity for being hardened by rapid cooling, which is characteristic of steel, and is due to the carbon the metal contains. Here is a knife of soft steel which bends readily; it contains some $\frac{5}{10}$ per cent. of carbon; if it is heated to redness and rapidly cooled, it becomes hard. Here is another knife, containing the same amount of carbon; heat it to redness, and cool it rapidly; it is softer than it was originally, instead of being harder. This remarkable material contains manganese in addition to carbon, and the manganese has entirely obliterated the action of the carbon. My last illustration is afforded by chromium. The presence of chromium in iron, together with carbon, confers extraordinary hardness upon this metal. A chromium steel projectile, 12 inches long, fired against the compound armor plates made by some of our most renowned makers, pierced no less than a 16 inch armor plate, which it shattered very severely; and conversely, a chilled iron armor plate containing chromium withstood a one-ton shot from a 17 inch Armstrong gun, propelled by over 8 cwt. of powder, and the shot only made a dent 1¾ inch deep, a most extraordinary result, when the enormous power of a ton shot so fired is borne in mind. Chromium has the same atomic volume as iron.

I must not go further this evening. I will only ask you to remember that the knowledge of the kind of facts we have considered comes to us from very early times, for the influence produced on metals by small quantities of added matter had a remarkable effect on the development of chemistry, mainly by sustaining the belief of the early chemists in the possibility of ennobling a base metal so as to transmute it into gold. This was the object to which they devoted life and health, and labored with fast and vigil. We inherit the results of their labors, and their prayers have been answered in a way they little thought, for, from an industrial point of view, if not from a scientific one, metals are transmuted by traces of impurity. Possibly we are nearing an explanation of the causes that are at work, but the fact remains that iron may be changed from a plastic substance, which in ornament can be fashioned into the most dainty lines of flow, into one of great endurance, from which shells and armor plate may be made. To this material, for the present at least, the defense of the country may be intrusted, apparently because carbon, manganese, and chromium have small atomic volumes.

* "Phil. Trans.," 1885, part ii., p. 463.

IT is said that the oldest rose bush in the world, of which there is authentic record, grows in a churchyard, and against the old church at Heldersheim, Germany. Eight hundred years ago, so the records say, Bishop Hepilo caused a trellis to be built, to support it. To-day the main stem is thicker than a man's body.

SIBLEY COLLEGE LECTURES.—1888-89.

BY THE CORNELL UNIVERSITY NON-RESIDENT LECTURERS IN MECHANICAL ENGINEERING.

I. THE PRACTICAL SIDE OF SANITARY SCIENCE.

By JAMES C. BAYLES, of New York City, President of the Health Department.

GENTLEMEN: When my esteemed friend, Professor Thurston, extended to me an invitation to fill this date in his annual star lecture course, he was kind enough, when I intimated a preference for some subject connected with or related to the work which at present chiefly occupies me, to furnish me an outline, and indeed a syllabus, of a lecture which, had it ever been prepared, would, I have no doubt, been found both interesting and instructive. There is, however, a curious tendency in the average human mind which the late Josh Billings has pointed out in his remark that "some men are like mules." If you turn them into an inclosure, they are certain to jump the fence—not because the pasture is any better on the other side, but in obedience to a law of their being. It is my intention to illustrate the truth of this sage utterance by offering for your consideration something wholly outside of the range of subjects so kindly furnished me by the director. Instead of giving you vital statistics and facts illustrating the value of sanitary science in its applications to cities, towns, and dwellings, all of which you can find very well presented in any general essay or accepted text book on sanitary engineering, I shall deal very largely with matters of personal interest, believing that until a person fully recognizes the value of health and the advantage of conserving it, general information on the subject of the mechanics of hygiene will have very little of either interest or value. I do not intend, if I can help it, that anything I say shall make you think you hear, with the poet, "Through rustling leaves, the chestnut pattering to the ground."

If the punishment attending a violation of nature's laws was sudden death, we should not only witness the law of the survival of the fittest operating with beautiful and beneficial celerity, but we should be reasonably certain to take care of ourselves in a way surpassing the wildest dreams of sanitarians. Curiously enough, however, we regard this matter in very much the light in which patriotism was regarded by the soldier in the Mexican war who refused to join a regiment carrying on its flag the motto "Victory or death." He said if it was "Victory or badly wounded," he would not object to joining; and it is in this spirit that most of us shape our life habits. We are willing to take unlimited chances of sickness and suffering, but so long as we stop just short of killing ourselves, we feel that the pleasure of indulgence is worth the price we have paid for it.

Within the past few years a new department of inquiry has been opened by the revelations of the microscope and the chemical laboratory. Upon the discoveries thus made have been laid the foundation of a new science of which all men of intelligence, certainly all men of education, and especially all engineers, should at least have a good general knowledge. In my school days hygiene, as taught in the text books, was a mixture of elementary physiology and arrant nonsense. The modern science of hygiene is based upon a good deal of sure knowledge concerning nature's laws, which has been patiently compiled and collated by some of the ablest men of the age.

We are also beginning to understand better than our fathers did the value of health, and that this is not a blessing conferred on some and denied to others as part of the divine economy, but is the normal condition of man, attainable in fair measure by almost any one who is willing to seek it. Fully impressed with a belief in this proposition, I have elected as my topic for consideration those elementary truths of hygiene which relate chiefly to personal habits, believing that I cannot better employ our brief hour together than in endeavoring to impress these upon your memory.

To young men still in the enjoyment of boyish appetites, and living in the boarding houses of a college town, it may seem like grim irony to say that overfeeding does more to induce sickness and shorten life than all other known agencies; but that such is the fact is accepted by all intelligent students of vital statistics. Curiously enough, this momentous truth never did, and probably never will, make any lasting impression on the public mind. Hospitality still largely consists in overloading the stomach. Pleasure tends almost irresistibly in the same direction.

We habitually over-feed at home, while traveling, in the city in winter, in the country in summer, everywhere and at all times.

It is safe to assume that a healthy appetite will lead its possessor into over-indulgence about seven days in the week, if he be so situated that he can get all he relishes. We become habituated to over-feeding from infancy. Nature rebels at first, and the baby whose stomach is overloaded throws off the surplus with perfect equanimity and an utter disregard of the feelings of others. By and by, however, the powers of adjustment are impaired, and the system acquires the ability to carry for considerable periods more food than it can assimilate, averaging matters by intervals of sickness of more or less severity and frequency. In the course of time the habit of over-feeding becomes fixed, and with it the evils it entails.

Indigestion, dyspepsia, rheumatism, gout, and other troubles are the price paid for the gratification of the palate at the expense of the stomach.

It is a well established fact that a healthy young fellow, taking plenty of exercise, can eat to excess without much immediate inconvenience. This immunity is but temporary, however, and is usually attended with more or less unfortunate consequences. The pleasures of the table are never so great as when good digestion waits on appetite; and the tendency to eat for the sake of eating is almost irresistible at a time of life when few pleasures are comparable to those which administer to the palate. But for the man who recognizes that he has an intellectual nature worthy of high development, such indulgence is more indiscreet than is often realized. I believe that scant rations in early life explain why it is success comes oftener to men who have emerged from comparative poverty than to those whose youth was surrounded by plenty. A full stomach conduces to a lethargic condition of the brain, in men as in animals. The man who is over-fed is incapable of a sustained mental effort; and if over-feeding is his habit, he soon becomes content to make the least use of his faculties consistent with necessity.

My advice is, prove all things; hold fast to that which is food. There is no virtue in a simple diet when the variety of wholesome and nutritious foods is almost without limit.

Food is fuel. The stomach is fairly comparable to a furnace. If you are in charge of a boiler from which you expect to get a great evaporative efficiency, you will not crowd into the furnace all the coal it will hold. You know very well that such a course would be disastrous, and vastly more productive of clinkers and cinder than of power. Too much fuel is as bad as too little. You would keep the grate clean, the ash pit free, and on the grate bars only as much coal as would maintain the fire at its best without deadening it. Small and comparatively frequent charges will give better results than larger and less frequent charges. Following this rule of diet, you will make no mistake.

The only dietetic rule which I desire to offer you is that which entails moderation in all things. It is a mistake which must be subsequently paid for, to eat until a feeling of repletion is experienced. I do not think with Franklin that a man should rise from the table hungry, nor do I believe Franklin ever did. I have learned to regard him as a propounder of platitudes at variance with his practice. But it certainly is a good rule to stop before you have reached the point when it is impossible to eat any more, so that you may rise from the table with that feeling of freshness and vigor of mind and body which is impossible in a condition of satiety.

Scarcely less important than eating is the subject of drinking. On this subject it is very easy to be intemperate and irrational. My experience during the past few years has strongly impressed me with the belief that no one ever made a mistake by taking radical grounds against the use of all forms of spirituous or intoxicating liquors. I have yet to have brought to my notice a single fact from which to draw the conclusion that alcohol has any important value except in the arts. There is absolutely nothing new to be said on this subject, and I do not intend to present any topic I may touch upon in these remarks in its moral aspects. I will say, however, that the young man who allows himself to acquire a habit of using liquor or stimulants does himself a great physical wrong, and handicaps himself more heavily than he realizes in the race of life. That he needs it, is benefited by it, or is made happier by the use of it, is a delusion so transparent that no one but a fool will seriously entertain it. It is but fair to say, however, that, in the judgment of those best qualified to form an opinion on the subject, more mischief in the form of disease, impaired vigor of body and mind, and premature death results from excessive and injudicious eating than from the habitual use of spirituous liquors.

But eating and drinking are not our only concern. We must breathe. To have good air to breathe we must have good houses to live in, and perhaps I can best give you my ideas on this subject by asking you to join me in the sanitary inspection of a dwelling which I have several times built in imagination, but have never yet had the opportunity to construct of more substantial materials. First, we will go down to the cellar. This is always the proper place to begin an inspection, as it is the place where, in the average dwelling, we are most likely to find conspicuously bad conditions. You will observe that there is neither standing water on the floor nor mould on the side walls. To use a favorite phrase, I had it made "as tight as a bottle." There are no pipes under ground, so you can see everything in the way of drainage appliances. The main drain of the house extends along the cellar wall, and is of stout cast iron, with leaded joints, well calked. You will see that this main house drain has all the pitch the height of the cellar admits of, and that it goes straight to the sewer without any trap. This omission is not accidental, but rests on a substantial foundation of good reason. If you will follow the soil pipe up through the house, you will find that it is carried full size to the roof, and that every joint is as tight as if a dentist had been called in to fill the cavity in the hub. I hold that any bad air which gets into one end of this pipe will go out at the other, and you can no more get up a pressure of so-called sewer gas within it than you could maintain an air pressure in a length of six inch stove pipe by blowing into one end of it while the other end was open. Moreover, we have no pressures to deal with. Personally I have no more objection to the sewer breathing through the soil pipe of my house than I have to its breathing through any other vent or opening, and I believe it to be the duty of the citizen who discharges his drainage into a public sewer to contribute something to its ventilation for the public good. But I have another and better reason for omitting the trap in the house drain. I want to keep that drain clean and to secure the maximum flushing efficiency of the water which passes through it to the sewer; and I have learned from observation and experience that a trap defeats this object more effectually than anything else could. Where there is no trap the house drain remains comparatively clean; with a trap it becomes indescribably foul, and this foulness makes a great deal of sewer gas on its own account.

The fact of the matter is, we are accustomed to blame sewers for much of the mischief which results from the decomposition of organic matter that has never reached the sewers, but is retained in our houses. I know a great many plumbers, having for some time had rather intimate official relations with them; but I never yet met one who was willing to admit that he had ever encountered in a new house standing untenanted, with all its fixtures complete and all connections with the sewer it will ever have, that characteristic smell which indicates the presence of what we call sewer gas. We get this in our houses after we have lived in them and fouled their pipes and fixtures.

But let us resume our inspection. You will notice that my soil pipe is only four inches in diameter, and is as heavy for its size as I could get. I would willingly have made it three inches, but as the larger fixtures are usually made with four inch outlets, it is better to give them a clean run to the sewer. You will notice that it receives at the head of the house drain the discharge of the roof leader. This is good practice if the leader is used for no other purpose, as the occasional rush of rain water helps to keep the house drain clean in the part where it is most likely to get dirty.

My furnace is in the cellar, too, but, as we are talking about plumbing, we will consider the heating apparatus afterward, to avoid confusion. Up stairs I have all the necessary conveniences of a modest but well appointed dwelling. I have not spared convenience through any mistaken notion that the house is likely to be healthier if plumbing fixtures are omitted, or used in rooms devoted to them exclusively. In my judgment, health and comfort are both promoted by having running water in, or in immediate connection with, one's bed-room. You will, however, find very few of what may be called the refinements of plumbing in my house. All is straight and plain work, planned upon a common sense basis and honestly executed. None of the fixtures are boxed in, my instructions to the builder being to leave everything open.

The principle on which the plumbing work is designed is one which admits of universal application, and which cannot be departed from without risk to life and health. It rests on the assumption, which nothing in experience has ever disproved, that air in motion will move along lines of least resistance, and that it will not force its way past an obstacle (as, for example, a water seal in a trap) if I gave it an easier outlet through a pipe which is wholly unobstructed, and which discharges into the outer air. That and good workmanship comprise the whole science of sanitary plumbing.

We deal with an elastic fluid, constantly in motion in obedience to natural laws and variations of temperature. Every vertical line of waste pipe should extend, without diminution of size, above the roof and open to the outer air. Branch wastes carried out from these to fixtures should be as short as possible, and should contain a trap intended to confine the air currents to the main lines of pipe. Each trap should have its water seal. The object of this seal is merely to close branch wastes against air currents not intended to flow into or through them. Seals have no other function. Provision should be made to preserve these seals intact by means of vent pipes extending from the crown of the bend of the traps, or some other device which will supply air when called for by the creation of a partial vacuum in the main vertical line, and so prevent what is known as the siphon action by which unvented traps are frequently unsealed. This is all there is of it. The more the system is complicated, the greater the danger.

In this climate the vitiation of the air of a house does not depend solely upon defective drainage. We need artificial heat, probably during seven months of the year, and unless the apparatus which furnishes this is well designed and properly operated, it is almost certain to vitiate the air in one way or another. Steam by direct radiation, and hot water circulation, are both unobjectionable on this score. They possess the disadvantage, however, of heating only the air already within the house, without making any provision for supplementing or changing it. In this respect the hot air furnace has a decided advantage for domestic use. But it is very seldom properly constructed or properly managed. Almost invariably it draws its air supply from the ground level. It should, in every case, be drawn from at least 12 feet above the ground level. From a somewhat careful review of a study of the subject from a practical standpoint, I attribute the usual bad effects of furnace heating to the following causes: Improperly constructed furnaces, impurities in the air heated, overheating of the air, and the lack of adequate ventilation in furnace-heated dwellings.

Before proceeding to consider these several sources of mischief, it is proper to say that I consider the hot air furnace, theoretically, and under favorable conditions, practically, a perfectly satisfactory method of heating dwellings.

But there are furnaces and furnaces. Some are made of spongy iron with sand holes in the dome and sides, and with joints so constructed that they cannot be made tight nor kept so. Warping opens their seams, and they leak the gaseous products of imperfect combustion into the air space surrounding the fire chamber. To such causes, or to cracks in the iron, we may always attribute the smell of coal gas noticed about the registers of many houses. There is no more reason why the gases of the fire should leak from the furnace into the air chamber than why the smoke should escape from the chimney into the upper rooms of the house. Defective flues and bad drafts are fruitful causes of leaking at joints, but poorly made, cheaply set furnaces cannot be accepted as the standard by which we judge the system.

Most of the impurities in heated air from furnaces are likely to be found in the air before it is heated. It makes a great deal more difference than is commonly supposed where this air is taken from. Sometimes it is drawn from damp, dark, and dirty cellars; sometimes from areas or under porticoes. More often than otherwise it is taken at the level of the ground and conducted to the furnace through boxes which are never cleaned. These are frequently mouldy tunnels—sometimes very foul. Air to be heated should be taken, as already stated, from as far above the ground level as may be convenient, and at a point where it is likely to be uncontaminated.

Overheating the air in furnaces is a fruitful source of mischief. It is customary to put in furnaces too small for the work expected of them. They answer well enough in mild weather, but in cold weather they have to be driven beyond their capacity.

When the furnace is overdriven and its radiating surfaces become very hot, the organic dust passing over them is charred and unpleasant and doubtless unwholesome smell is produced. It is good sense and good economy to provide ample heating facilities, and run them with moderate fires.

It is important to remember that satisfactory furnace heating is impossible without ventilation. You must, at least, have an outlet for as much air as the register discharges into the apartment, and this should be so arranged as to remove the cooler and impure strata lying along the floor, and give the warm air which flows to the ceiling a chance to fall to levels where it will do most good. It is the experience of furnace men that rooms with open fireplaces are more satisfactorily heated than rooms without, even when they have no fires in them to induce an upward current in the flue. This gives the now fashionable open fireplace another and better claim to favor than it has as an ornament or as a means of practical heating.

The question, How is the householder to know whether his furnace is a good one or not, and whether it is large enough? is very easily answered. He can determine the question of size experimentally. If he ever has to run his furnace strong, or to make any part of it red hot to get heat enough to keep his house warm, he can decide without other advice that it is too small for the purpose. If, on the other hand, it does its work easily with a moderate fire, and is able to heat a large volume of air to a moderate temperature, he may assume that it is large enough. He can also experimentally determine whether his furnace is a good one or a poor one. If, when the fire is bright and in good condition, he will throw in through the feed door a pair of old boots, an Arctic overshoe, and a marrow bone, and will then give the furnace the indirect draft, and go up stairs, he will know whether the joints are tight and the furnace capable of retaining within its fire chamber and dome the gases resulting from imperfect combustion of coal. This, by the way, is a good experiment to suggest to some of the gentlemen who are in the habit of making strong claims for their furnaces. If, in buying, some such test as this, to be applied to the furnace in actual use, is made a condition precedent to acceptance, it will be found that very few furnace makers would show any eagerness to take the order. It is not, however, an improper test. If the furnace is properly built, the connections with the smoke flue clear, and the flue itself a good one, you can burn anything you like in the fire pot.

Whatever the importance of ventilation, it is scarcely worth while, in the present state of public opinion, to advocate provision for this purpose.

I know of no way of ventilating living and sleeping rooms which, to my mind, is as satisfactory as flues terminating in open fireplaces. These flues develop a tendency to "draw," as the saying goes, under all but exceptional circumstances, even when the flues are cold. Between flues of this kind and windows one gets all the ventilation a reasonable man has any use for.

The man who has an intelligent appreciation of the benefits of pure air will not be long in discovering that carpeted floors are an invention of the enemy. I am happy to say that in my house such a thing as a carpet nailed to the floor cannot be found. Every floor covering should be loose and easily removable. It should cover only the center space of the room, and should not extend under the heavy, bulky articles of furniture which are usually placed against the wall.

In a healthful dwelling, walls and ceilings demand more thought than they usually receive. I do not think much of wall paper, but I have great faith in what is known as distemper—a preparation of water color and size—to which I am very partial. This form of coating is inexpensive, may be removed by the muscular application of a wet sponge, does not destroy the porousness of plaster, which has a valuable function, and admits of the most tasteful and harmonious color effects. There are many reasons why plain walls are better than walls covered with elaborately ornamented paper. Primarily, they show when they are dirty, which is an advantage, as they are more likely to be cleaned and refreshed. The paste with which paper is made to adhere to the walls usually decomposes in a comparatively short time, and undergoes fermentation, which is not conducive to the purity of the air. We are also likely to encounter in wall paper arsenical colors, and these are known to be dangerous. But, however made, wall paper is unhygienic. It is a great shelter for dust, and usually looks very well long after the only proper thing to do with it is to tear it off and burn it. All things considered, I prefer to use very little of it, and desire to keep my walls pervious. A great deal of ventilation goes on through the walls, which, though not felt as sensible currents, effects a constant change of air, and tends to destroy, by oxidation, the organic impurities which walls are sure to absorb.

It is too late to apologize for the didactic tone of this address. Its character is pretty well determined by this time, and I might as well continue in the vein I have chosen. I intend to say something about sleeping, which, after eating, drinking, and breathing, is, perhaps, the most important function of life. What are good sleeping habits?

The sensible man who properly values health should very soon find out what are good sleeping habits for him. Sleep which is not restful and refreshing points to causes of unrest which should be sought and corrected. Do not take any advice on this point, but consult your own experience. If you have never given the matter any thought, it will not take you a week to determine empirically what is best for you. Above all things, do not be deluded by what old people tell you of the advantages of discomfort. They delight to spin yarns of how, when they were boys, they slept in attics without any attempt to warm them, and how the snow used to sift in and pile up on top of the bed clothes. To this they will attribute the youthful vigor of which they are fond of boasting, and the long life which, in the inscrutable economy of Providence, they have enjoyed. It is the tendency of such old romancers to bewail the degeneracy of modern youth, and to assure those who are willing to listen to their maunderings that the only way to be healthy and happy is to suffer as they did. This is bosh, pure and simple. Exposure to low temperatures involves a struggle to maintain life. This struggle is attended with a waste of tissue which is only partially repaired, and which breaks the constitution before middle life is fairly reached. In our winter seasons one encounters all the cold needed to keep him well without taking it to bed with him.

Generally speaking, I do not favor the use of bed rooms as sitting rooms. Apartments used as dormitories should be well aired during the day, and should have the benefit of all the sunlight that can be given them. When the weather permits, the windows should be left open long enough to give them that fresh and wholesome smell which every bed room should have. If, during the time of their proper occupancy, they can be kept comfortably warm, so much the better.

While on this subject, I may venture the suggestion that a proper regard for health requires that every adult should, if possible, sleep alone. This rule should, I think, be followed in all households. The intelligent man who once acquires the habit of sleeping alone will never change it, whatever the inducement, unless he ceases to be sensible.

On the subject of exercise my opinion differs somewhat from that of others, who will doubtless be considered better informed and more intelligent, at least they so consider themselves. Gymnasium exercise, if indulged in at all, should be under the direction and tutorship of an accomplished and reasonable instructor, who will resolutely forbid any of the foolishness which one sees in every gymnasium he may enter. Mr. Blakie, one of the most sensible writers on this subject who has ever contributed to its literature, states with great confidence that a man should never begin anything in the way of systematic muscular training under the age of twenty-five. Of course, he does not mean by this to fix an arbitrary age limit, but to convey the idea that the majority of men do not attain a sufficient maturity of body under the age of twenty-five to make training for athletic sports demanding great strength or skill safe or desirable.

But I do not intend to dwell at any great length upon this subject, which, as I have said, is one concerning which we find great differences of intelligent opinion. My advice to young men would be to exercise abundantly, but with the same judgment which I have advised in every other function of life. It is not likely that the student or the young man of business will get too much exercise in the outer air for his own good. Long and rapid walks, with that free swinging gait which, when once acquired, no man will ever abandon until crippled, should be systematically practiced, and nothing should be allowed to interfere with this or its equivalent.

To the young man whose best energies are devoted to the acquisition of an education, and whose studies claim a fair portion of his time, I would recommend working to schedule. In no other way is it possible to compass the requisite physical exercise. There should be study hours and play hours which are not interrupted by any ordinary daily happening, and the student should as conscientiously devote himself to changing the residual air of his lungs, stretching his legs and imparting vitality to his muscles, as he does to acquiring the studies in which proficiency is demanded as a condition of graduation. To make out a time table and adhere to it involves some self-denial. It requires a regular hour of rising, and a determination to make pleasure in every case subordinate to duty. But if this habit is once acquired, it lasts for life, and is attended with the greatest benefit. Purposeless and solitary walking I do not consider of much value. It is a great deal better that every walk should have an objective point, and every walker one or more companions. What becomes irksome if done in a perfunctory way, and simply because it is deemed a necessity, becomes a rare pleasure when performed with good company and under conditions which encourage a spirit of emulation. But walking is not alone sufficient. There should be due attention given to the expansion of the chest and the development of those muscles which contribute to strength and endurance. A gymnasium is not necessary for this, as it can be had in many ways.

The advice which I would give to the young men I have the pleasure of addressing is to form exercise clubs. These should be of convenient size—not less than four nor more than twelve. Every club of this kind should have for its object an intelligent study of physical culture, and the regular and systematic practice of exercise calculated to do the greatest good to the greatest number. By such a club tramps are planned with gradually increasing distances to be covered, until the members become expert walkers; and other beneficial recreations are devised and carried out much better and more certainly than is possible to the individual. From the conferences and discussions of such a club a great deal of useful knowledge will be gained, as it is probable those reponsible for its management will seek the best works on the subject of physical culture, and advise themselves on all that pertains to the kind of development of which the average student has most need. Our English friends are much wiser in these matters than we are. They have all sorts of exercise clubs, chiefly for mountain climbing, which has become a favorite fad of the Englishman who has leisure and means for travel. In the organization of such clubs an opportunity is offered for that kind of natural selection which determines affiliations and companionships; and with a resolute president, who is himself an enthusiast on the subject of physical culture, there is no reason to doubt that membership in such a club will give the young man all the exercise for which he has need, as well as all the information he requires to enable him to exercise wisely and with a clear purpose.

In these desultory and, to some extent, disconnected remarks, I have covered pretty much all that seems to me essential to an understanding of the science of personal hygiene. No doubt some who have honored me with patient audience may say that I have stated nothing new, and advanced no surprising propositions. Permit me to call your attention to the fact that in this respect my lecture is unique. I have no theories, and if I had, I should not care whether other people accepted them or not. In presenting the subject in this lecture I have endeavored to deal with it in its common sense aspects, leaving all mooted questions to be disputed by those who have more fondness than I for purposeless discussion. Permit me to conclude with a parable which he who runs may read. There was once an artist, the greatest the world has ever known, who painted a picture, the most beautiful ever seen. Day by day, for years, he wrought upon this masterpiece, developing it from a sketch until it became a picture which all who saw it delighted to look upon. But notwithstanding his wonderful power, the artist could never attain in this work the perfection sought. His colors seemed to change in the night. The flush of health which his facile pencil imparted to cheek and brow were lost as often as renewed. The flashing eyes grew dull and leaden, and seemed to sink into the canvas. The beautiful flesh lost its rose-leaf tint and became sallow and unnatural. His art was baffled and he knew not why. But it was not that his hand had lost its cunning, that his colors were impure, or his conception at fault. His work was well done, but it was spoiled in the night by an enemy, a rival painter whom none praised and whose work none admired. Jealous of the fame the other had won by joyous, glowing pictures, while his own somber works were shunned and held in dread, he crept by night to the studio of the other, and with a palette spread with shadow tints wrought ruin with the work he could not imitate. Thus the picture which should have excelled all pictures never attained perfection, and was ruined at last beyond all hope of restoration.

Need I name these painters? They are Health and Disease. Health creates in our homes pictures which for us are fairer than any painted by man. Let us see to it that our doors are guarded, and that Disease shall not enter through some neglected portal to spoil this matchless work; to turn the glow of vigorous health into the sallow tints which mark enfeebled vitality; to blot out the light which sparkles in bright eyes or ring them with umber; and that he shall not wreak his last and worst revenge, and spread over the faces we love to look upon the pallor which bids us look no longer. Time will do all this full soon, but let us take care that his work is not anticipated, and that if Disease finds entrance it shall not be through open doors or neglected windows, where duty bids us stand warder.

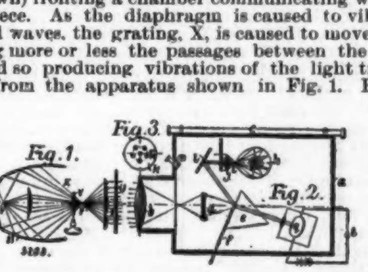
PYORRHŒA ALVEOLARIS IN AN ELEPHANT.

THE steadily progressive course, the intractability under treatment, and the frequency of the disease known in this country as pyorrhœa alveolaris have caused a great deal of attention to be devoted to it, especially by dentists, and the subject has been brought forward several times at the dental societies, but very little light has yet been thrown on the subject. The recent researches of Mr. Bland Sutton have established the fact that animals kept in captivity are liable to suffer from premature loss of the teeth, with wasting of the alveoli—in fact, from a disease closely resembling pyorrhœa alveolaris. He found also that the young of animals born in captivity were very liable to suffer in this way in conjunction with rickets. M. Gallipe showed, at a recent meeting of the Société de Biologie, a report of which is given in the *British Journal of Dental Science*, the tooth of an Asiatic elephant which came away spontaneously. To all outward appearance the tooth was perfectly sound; the root, however, was covered with a crust varying in thickness in places from three to four millimeters, and was of a calcareous appearance. The inferior extremity of the fang appeared to have been the seat of a rather severe pathological process, and presented sharp ridges quite incompatible with a normal state. "We found," said M. Gallipe, "that the calcareous crust covering the root consisted of salivary tartar—*i. e.*, micro-organisms which had caused the deposition of the calcareous salt dissolved in the saliva. The cementum was the seat of every degree of change, from the most superficial erosion to its almost complete disappearance; micro-organisms were found not only on the surface, but even in its very substance. In several spots where the dentine was exposed, it was found to be the seat of more or less deep excavations covered with masses of micro-organisms, disposed more or less in a regular order. These micro-organisms were found to have penetrated into the canaliculi, and we were able to follow them for a considerable distance into the dentine. These lesions do not present any essential difference from those M. Malassey and myself have found in man. We come to the conclusion that the Asiatic elephant, when kept in captivity, may be affected with the disease which we have described in man under the name of infectious antro-dental gingivitis.—*Lancet.*

APPARATUS FOR TRANSMITTING SOUNDS TO A DISTANCE BY MEANS OF LIGHT.

By L. J. LE PONTOIS, Paris.

REFERRING to Fig. 1, the fixed light, F, is situated in the focus of an elliptical reflector, H, causing the rays to converge to the other focus, F', beyond which are fixed the lens, T, and the colored glass, U. In the path of the rays toward these is interposed a vibratory apparatus consisting of two gratings, X and Y, having coincident openings between their bars; the one, Y, is fixed, and the other, X, is free to slide in a guide, and is connected by a magnet and armature to a diaphragm (not shown) fronting a chamber communicating with a mouthpiece. As the diaphragm is caused to vibrate by sound waves, the grating, X, is caused to move, obstructing more or less the passages between the bars of Y, and so producing vibrations of the light transmitted from the apparatus shown in Fig. 1. Fig. 2



illustrates a receiving apparatus in which the varying light is caused to act on the telephonic receiver. A dark chamber, *a*, is provided with a finder telescope, *c*, and is mounted so that it can be directed so as to receive the parallel transmitted rays on its lens, *b*, by which they are converged. The rays diverging beyond the focus of *b* are again conveyed by an achromatic lens, *d*, and thrown on the face of a prism, *e*, which is blackened, except in one place for their reception, and is provided with a sliding screen, *f*. In order to render more effective the rays falling on *e*, they are reheated by combining them with hot rays of their complementary color. The reheating is effected by means of a lamp, *g*, within a reflecting case, *h*, through an opening, *i*, of which the rays pass to a lens, J, rendering them parallel. In front of this lens is a circular screen, *k*, shown in front view in Fig. 3, having through it several openings, *k'*, fitted with green glasses of various depths of tint. By turning *k* round, one or the other of these glasses may be brought into line for the rays to pass through it to a reflector, *l*, by which they are thrown upon the prism, *e*. A small telescope, *m*, enables the observer to see the incidence of the rays on *e*, and make the necessary adjustments to bring the green and red rays together on *e*. The combined rays are transmitted through a lens, W, on to a selenium resistance, *q*, forming part of the circuit of a telephonic receiver, *t*. As the selenium is acted on by the varying heat rays from W, the variations of its electrical resistance thereby caused are converted by the telephonic receiver, *t*, into sound waves corresponding with those which acted on the transmitting diaphragm.

[Illustrations.]

IONA AND STAFFA.

Lonely and grand in the midst of the sea, about nine miles in a northeasterly direction from Iona, is found the subject of our present article—the Isle of Staffa. Until comparatively recent years it was hardly known to any except a few natives of the neighboring isles, Sir Joseph Banks being the first person of note to visit and describe it. While on a voyage to Iceland, in 1772, he dropped anchor, on August 12th, in the Sound of Mull, close to the residence of a certain Mr. McLeane, who invited him to his house, where he met an English gentleman named Leach, who informed him that about nine leagues from where they were was "an island, where he believed no one, even in the Highlands, has been, on which were pillars like those of the Giant's Causeway." He at once set sail for it, with a small party, in one of the ship's boats, and arrived about nine o'clock in the evening, after what he describes as "a tedious passage" of about eight hours', duration. As nothing could be seen at that late hour, a camp was formed, and further operations deferred till the next morning. A thorough exploration was then made, and a good description in due course published, the direct consequence of which was that Staffa began to be visited both by scientists and tourists in considerable numbers, till at last it became quite famous, and in 1847 was even visited by the Queen and some members of the royal family.

When viewed from a distance, there is nothing very striking about it; it appears to be but an irregular flattish rock, rising a little from the surface of the water, and offering no encouragement to the visitor to expect to find anything out of the ordinary, upon landing; in fact, so commonplace is its appearance, that one may well be excused for any feeling of disappointment that arises, and for thinking that far too much has been made of it. However, while these thoughts pass through the mind, the boat continues its approach, the rocky headlands and perpendicular walls become momentarily more distinct, till by the time the shore is reached, the disappointment is all gone, and one is quite ready to agree with everybody who says anything in a laudatory strain about it. It is so different from everything we are, for the most part, accustomed to see on our coasts—so wild, so strange, so grandly picturesque—that one cannot fail to wish to know more of it, and is eager to explore its every corner.

In regard to the general character of the island and the nature and formation of the rocks, roughly speaking, there are three distinct layers, the lowest being a bed of conglomerate trap tufa, which is inclined a little toward the east. Upon this rests a remarkable formation of columnar basalt, the pillars of which are mostly of great regularity and beauty. This is surmounted by a thick stratum of solid basalt, which contains many broken blocks and columns, congealed, as it were, into the mass. The top is slightly covered with alluvial soil, and in most places clothed with good grass, though here and there broken ends of columns peep through, and blocks of bare rock show themselves. Almost in the center of the view may be seen the entrance to Fingal's Cave—Staffa's greatest wonder—a gigantic natural hall formed by the breaking away at this point of the basaltic columns. It stretches inward a distance of over two hundred and twenty feet; its height varies from about seventy to forty feet, and the general breadth at the entrance is about fifty feet, and at the farther end a little over twenty. The walls are formed of the columns previously alluded to, packed closely side by side, and the roof of the top layer of basalt, from which broken-off portions of the pillars in many parts depend. From the entrance this cave looks gloomy and forbidding, but, viewed from the interior, it is like a fairy palace. The floor is covered, to a depth ranging from about eighteen feet at the entrance to nine at the extremity, by the sea, which appears a delicate transparent green, contrasting splendidly with the dark tone of the rocks. From this the light is reflected in a myriad soft beams on to the walls and roof, dancing and playing mysteriously around, and causing the whole place to glitter and sparkle in a most enchanting manner, revealing many cavernous recesses and fantastically formed prominences. To these circumstances, which delight the eye, must be added the weird music of the water which greets the ear as wave after wave rolls into the cavern, and spends its force against the rocky sides. The sound is echoed and reechoed throughout the chamber like the muffled peal of distant thunder, and not only does much to add to the sublimity of the scene, and stamp upon the mind of the beholder impressions which are not easily obliterated, but fully justifies the bestowal of the Gaelic name, "Uaimh binn," or the "Musical Cave," by which it is known. The origin of the more generally used name, "Fingal," is given by Sir Joseph Banks, as follows: "We asked the name of it; said our guide, 'The Cave of Fiuhn.' 'What is Fiuhn?' said we. 'Fiuhn MacCoul, whom the translator of Ossian's works has called Fingal.'"

Trending away from the mouth of the great cave to the northeast, is a fine causeway formed of the tops of a large group of columns protruding from the sea, and making a flat, regular surface of good width—a sort of natural esplanade—upon which one may walk for some distance. The columnar stretch of cliff at this point is very fine and regular, and is known as the Great Colonnade. It extends from Fingal's Cave to the Clam-shell Cave—a very curious and interesting one, though smaller than the great cave. On one side of the entrance, the pillars of basalt are bent and huddled together in a most remarkable way; and on the other, at the upper part, present only their tops to the eye, which gives the surface a tesselated appearance; while on the lower slope they are laid out horizontally, like a stack of logs. The cave itself is about one hundred and thirty feet long, and about thirty feet high near the entrance, but gets smaller as it recedes inward. Close to this cave, at the end of the colonnade, is a curious conical pile of pillars, known as the "Buachaille," or "Herdsman." From this point northward the pillars get less regular and smaller, and in places are altogether absent. There are, however, several small caves, but they are quite unimportant by comparison with those already mentioned. The west side of the island becomes higher, more rugged and picturesque, with frowning headlands and rocky bays; and at the southwest corner there exist two caves of considerable dimensions, namely, the Boat Cave and McKinnon's Cave. The former is about one hundred and fifty feet long, and nearly twenty high; it can only be entered by boat, and from this circumstance takes its name. The latter is larger, its length being but a few feet less than that of Fingal's Cave; its height fifty feet, and breadth about the same. It is not columnar, being formed in the basal stratum of the island. It is a favorite retreat for the cormorant, which is found in such large numbers as to cause the cave sometimes to be called the "Cormorants' Cave." The birds congregate in enormous multitudes in almost every crevice, and on the various ledges of rock, and there find a secure and sheltered roosting place, with only the wide expanse of sea around them.

Staffa has no human inhabitants; it lies in too exposed a position for this; but now and then sheep and cattle are taken there to graze, for the grass is good. It forms, however, a favorite home for sea birds of many kinds, and, in addition to the cormorants, one may see numerous gulls wheeling gracefully about on silvery pinion, and filling the air with their plaintive cry; while the odd little guillemots and quaint-looking puffins crowd upon the rocky ledges and promontories, or gambol about in the translucent sea—a very picture of joy and liberty, of unsullied nature. Here, in thousands, they are born, live, and die, the bare rocks their cradle, the wild music of the wind and sea their lullaby, the caves their home, the deep their foraging ground, and at last their grave.

On the rocks which are within reach of the tide are various marine objects of interest to the naturalist, while the curious cliffs have their own silent and impressive story to tell to the geologist, and will supply him with ample material for many days' careful thought and interesting study.

Theo. Carreras.

WEST POINT AS SEEN BY AN ENGLISHMAN.

A British officer furnishes the New York *World* with an account of a visit to West Point and some criticisms on that school. First, we have a description of General Parke: "A very distinguished, military-looking man, enveloped in a huge army overcoat. Tall, slight, and of a very upright figure, he looked every inch of him a general officer. He had the fresh, clear complexion noticeable always in a man who is accustomed to out-of-door work. His full, strongly marked features were set off by a thick head of gray hair, with gray mustache and well-trimmed side whiskers. The funny little French cap placed jauntily on his head completed the attire of this officer. He was accompanied by two very aristocratic ladies, evidently his wife and daughter. Our talk at luncheon is principally of a military description. The General is very anxious to know my impressions of what I have seen already at West Point, and having given them to him in almost the same words as those noted here, with a few rather more outspoken ideas, he appears to agree with me in most of my criticisms."

The adjutant is described as Mr. Brown, a cavalry officer who has spent the greater part of his service engaged in staff work, who is thoroughly conversant with all branches of the army, and is a most pleasant companion.

Of his inspection of the riding school, he says: "I am not much struck with the general appearance of these horses; their legs are too long and lack the beautiful flatness and symmetry of the English troop horse; their bodies short and a decided semblance to the mule about the head—altogether making an extremely ugly animal, with no hopes of turning him into a showy horse on parade. But as I glance upward at the saddles, bridles, and bits, what a dreadful sight meets my eye! Rust of months accumulated on the two latter articles of saddlery, with no attempt even of removal, and the leather hard and cracked in places from the want of scrubbing and soft soap." This is contrasted unfavorably with the care taken of saddles in English cavalry stables, including that of the cadet colleges at either Woolwich or Sandhurst, where they have detailed to this work soldiers who have served a term of years with their regiments and are familiar with it. Our critic says: "It is to be wished that your cavalry were more particular, if only for the sake of the horse's mouth, which in course of time a rusty bit is bound to injure in some way or other. Now your cavalry saddle is indeed a far better one than ours. Not so smart-looking, but infinitely more useful."

Marshaled in line, with sabers drawn, the cadets present a very good appearance and look as if they ought to be able to stick on to anything. The horses, with their unsoldierlike, slack, slovenly, and dirty grooms, drawn up in rear of their destined equestrians, and outside their stable, taken *en masse*, indeed look a sorry lot. I miss the champing of a bit, the throwing up of the head, and the showy appearance of our troop horse generally when I look at them. The order is given to return swords and stand to their horses. Each cadet chooses the horse opposite to him when he faces about, and the individuals facetiously termed "soldiers" slouch out of the school and await outside any order that may be given them.

"Prepare to mount," "Mount," "File to the right and circle," quickly follow in the sharp, decisive tones of the word of command given by the riding master. "Draw swords," "Trot."

Now begins my criticism as I stand in the gallery; nor have I to wait long to find grievous fault. A few cuts and points are being performed by the cadets. They are what is termed riding on the right rein, which means really they are circling to the right, as it is called in this country, but in ours "going large" to the right; consequently every cut is to the right, as the board prevents them from executing the left cuts.

As each cut is given, every horse swerves nearly into the middle of the school. I look to find the reason of this, and quickly discover its cause. In nine cases out of ten, in bending down to deliver the low cuts the cadet's spur or heel comes in contact with the horse's left flank, and being accustomed to obey the pressure of the leg, he naturally swerves in the opposite direction. Of course, as every cavalryman knows, the pressure should be given to the side on which the cut is delivered to keep the horse at the requisite distance to make the cuts serviceable, for by the animal swerving into the object aimed at, half the power of the arm is gone, and he is liable to come down with the flat edge of the sword on to the shoulders of his intended victim. Again, there is no uniform distance between a horse's nose and croup, and seeing these energetic youths slashing with might and main at imaginary foes, I tremble for the safety of the next horse's head, and fully expect to see ears severed from their owner's cranium, flying in all directions. However, by great luck no such accident happens, and we are spared the pain of witnessing any catastrophe of this description.

Now, in the cavalry education practiced at West Point there are many points greatly to be admired, and one regrets that they are not put into use generally at home. The first is the picking up of the sword from off the ground when mounted, a feat comparatively easy to accomplish to the lookers-on, but in reality by no means so easy as it looks. I need not explain the usefulness of this exercise, for it explains itself. The next is the cutting of the sword exercise with each hand in turn. It teaches the soldier to rely equally on both hands, and if one should happen to be wounded, the sword can be transferred to the other, and with but little inconvenience experienced to the owner. Mounting a bare-back horse while at the gallop is constantly practiced here, and I am surprised at the seemingly easy manner in which the cadets accomplish it. Heads and posts and other cavalry evolutions are gone through in their turn, and altogether a very thorough and complete riding lesson has been given, with the exception of a few faults I have quoted above. As a school for irregular cavalry, I should say that West Point has not its equal, and certainly as a competent teacher the instructor has not his better. . . .

I have never seen such a splendid system of drawing carried out with such precision, and as this branch, as well as everything taught here, is compulsory, every one attains a certain amount of proficiency far above the average run of European cadets.

We move on to the next room, where I am introduced to the instructor of ordnance, and being asked if I would care to listen to some of the recitations, I gladly assent and seat myself next to him at his table. Drawn up in line with backs toward us are some dozen students engaged in illustrating the means of heavy gun transportation on huge slates nailed to the wall. The instructor himself, with half-closed eyes, leaning comfortably back in his chair, is listening to the recitation of one cadet who is standing strictly at attention before him and answering with great correctness the questions put to him. This officer has no book in his hand, and but for his shrewd questions and learned explanations one would imagine that he was paying no attention whatever to the lesson he is engaged in hearing; and when it comes to the turn of the next one to expound his theories, he just glances at the slate to see that his work is correct, and assumes the same apparent but deceiving carelessness.

I do not propose to enter into any elaborate description of the various recitation rooms I entered. Let it suffice that the schoolmaster and schoolboy are respectively personified here more than in any other place in the college. The cadet stands up to attention, and with the exception of his not having his hands behind his back, presents the appearance of a national schoolboy saying his lessons. Even at our public schools we sit in rather a negligent manner and repeat our work in a free, unconstrained tone of voice, and after having left school and entered a military crammer's all restraint is thrown off and we are treated as students, and not boys. Smoking is allowed, and unrestrained liberty, trusting to the desire to pass examination to keep us within the bounds of rational recreation. And yet we manage to pass about the stiffest examination for any army known, and are no wilder when we join than the average American lieutenant who has graduated in such an exemplary, proper school.

I strongly disapprove of the system at West Point of treating the cadets as schoolboys, as all, or nearly all, are destined to become officers of the United States army, and should begin to consider themselves as men and to behave as such. They are even in receipt of pay as cadets, but are not allowed to touch it. They are not allowed pocket money, a privilege that is never denied our schoolboys, in case it may lead them into evil ways.

Life at West Point and life at Sandhurst or most other European colleges differ so widely from each other that one finds it a matter of the greatest difficulty to make any comparisons whatever. No boy in any of our public schools is so strictly watched and has so little time for recreations. In fact, West Point strikes one at first as being a school of grown-up young men impersonating boys and going through the same amount of lessons per diem and general routine, with this exception, that, instead of having games, they devote their time to drill and are exercised in the various functions of a soldier.

Of course, I quite see the advantage and necessity of treating them as private soldiers on parade and at their various military duties. But is it not carrying things rather to the extreme in making them scrub their floors and perform other functions usually carried out by the lower class of servants? It is not fitting work for a future officer of a great country to be engaged in week after week, nor can it be pleasant for officers to find fault with and reprimand him for any neglect in these duties, knowing that the offender will one day don the sword and epaulettes of a second lieutenant of the United States army and be on a par of social standing with the highest officer of the college. No; I believe this to be a great mistake, and one that could easily be rectified by having special men detailed for the rooms of the cadets, and who should be answerable for the cleanliness of them to the inspecting officer.

At the artillery exercises, in charge of one of the guns is a colored cadet, black as the raven, with no sign of white blood in his veins, and with the rolling, yellow eyeballs of the thoroughbred Nubian negro. He is a well set up, smart, soldierlike young fellow, is perfectly at home in this branch of his education, and, as I learn, is as good in every other. But it must be very galling for the white cadet even to be supervised by a colored man, but what must his feelings be to be told that he has no energy, and to have the sponge snatched out of his hand and the proper way of cleaning a gun practically illustrated by this smart young colored gentleman? Again is the order given and again is the white man at fault and corrected with even more sternness than on the former occasion. Not a word, a sign, or a look escapes from the lips or is shown on the counte-

nance of the recruit thus admonished, and yet imagine his feelings, and you cannot help admiring the system which produces such excellent results.

Altogether, taking West Point as a school of military education, it ranks higher than any I have ever seen. It turns out officers who are capable, industrious, and hard working, with every loyal feeling to their country and interest in the coming race of officers. They all look back at their life at West Point with pleasure, showing that to the American boy at least this form of education is not distasteful; nor does it appear so hard to them as it looks to a foreigner. In conclusion, I should like publicly to thank Gen. Parke, Captain Price, and Mr. Brown for the kindness they have shown me during my brief visit to their academy, and for their courtesy in showing every little detail of management to the critical eye of a foreigner.

A FUNGUS FORAY.

The Yorkshire Naturalists' Union lately organized an excursion of a novel and decidedly useful character, under the title of "A Fungus Foray." This was fixed for Tuesday, September 25, when the members, after a long day's collecting in Bramham and Harewood parks and woods, met at the Leeds Philosophical Society's Library to compare results and arrange the show. The chair was taken by Mr. G. Massee, F.R.M.S., of the Royal Herbarium at Kew, an old member of the Union and an authority on the subject, who gave a short address on "The Past and Future of Fungi." On the following day the show was thrown open to the visitors to the Leeds Museum. A great number of people took advantage of the opportunity of seeing so interesting a collection. The illustrations, which represent some of the most striking specimens, have been drawn for us by Mr. R. Fred. Reynolds, of Leeds, who also furnishes the subjoined descriptions:

No. 1. *Amanita Muscaria.*—The fly amanita is a magnificent scarlet in color, dotted here and there with white papillæ. It is poisonous, and generally found from August to November in woods, particularly fir and beech.

No. 2. *Amanita Rubescens.*—The reddish amanita, though common, is extremely handsome; it is found in woods, and is esculent.

No. 3. *Panus Stypticus*, as its name indicates, was in days gone by used as a styptic, being dried and powdered for that purpose. Generally found on twigs, etc.

No. 4. *Agaricus Nebularis.*—Pale brown gray.

No. 5. *Clavaria Vermiculata.*—The candle clavaria, or white-tufted clavaria, met with during wet weather in pastures, lawns, and roadsides. Highly esculent.

No. 6. *Lactarius Deliciosus.*—The delicious milk mushroom, or orange milk mushroom. Its juice turns a beautiful green color on exposure to the air. Found in fir woods from September to October. Esculent.

No. 7. *Lactarius Subdulcis.*—Sweet milk mushroom. This is pinky brown in color, extremely elegant. Found in woods from September to October. Common.

No 8. *Coprinus Comatus.*—Shaggy or maned mushroom. "The agaric of civilization." Found on roadsides, pastures. Edible.

No. 9. *Agaricus Galericulatus.*—Little cap mushroom. This delicate little fellow is found on trunks of trees, and is very common.

No. 10. *Agaricus Phyllophilus.*—Leaf-loving clitocybe. Here depicted growing on birch leaves; an extremely beautiful specimen.

No. 11. *Agaricus Inopus.*—Bolton's flammula, named after a Yorkshire naturalist. It is of a dirty yellow brown color, and found on stumps of trees. Rare.

No. 12. *Lycoperdon Pyriforme.*—Pear-shaped puffball. Mousey-brown color, and found on decayed stumps.

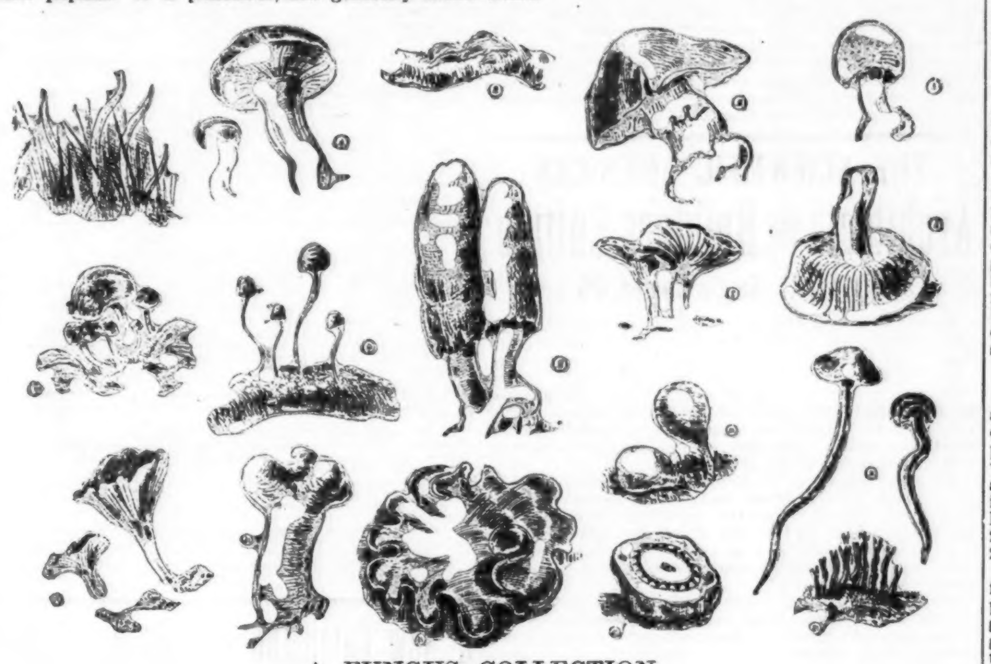
No. 13. *Calocera Viscosa.*—The clammy calocera. This is remarkably beautiful in form and color, being of a most lovely orange red, and having a waxy appearance, rising about 2¼ to 3 inches out of the ground.

No. 14. *Phallus Impudicus.*—The stink horn. Is one of the most interesting of the fungi; it is generally seen in a spherical form slightly projecting above the ground (sketch shows specimen cut in two). It elongates; in so doing the upper portion becomes covered with a sticky jelly which was previously within the outer coating. This attracts insects. Odor strong and most unpleasant.

No. 15. *Polyporus Celulinus.*—Razor-strop fungus. This specimen measured about eighteen inches across, and had that peculiarly smooth, leather-like surface which has recommended its kind, as the name implies, for the purpose of sharpening razors.

No. 16. *Lycoperdon Germatum.*—Warted puff ball. This is an abnormally large specimen, of a brown-gray color.

No. 17. *Agaricus Phyllophilus.*—Leaf-loving clitocybe.—*Chemist and Druggist.*



A FUNGUS COLLECTION.

[Garden and Forest.]

WINTER APPLES.

The Baldwin is the most satisfactory winter apple, as well as the most popular variety in this vicinity, and yet in the southern part of this State it is regarded as a fall apple, and esteemed only as such. I confess its record for keeping qualities is not as good here as it was once, but its size, beauty, flavor, and fine bearing qualities render it a general favorite notwithstanding.

The universally popular Rhode Island Greening is still a great favorite, but it does not grow as smooth generally as the Baldwin. Neither does the tree grow as well. Its reputation as a keeper is also on the wane; and this will apply to all of our apples once famous for long keeping. It was not unusual years ago for farmers to have a generous supply of apples in April and May, a thing now very rare indeed. The cause or causes contributing to this changed condition give rise to much speculation, but no conclusion that is generally accepted has yet been reached. Possibly new varieties may be developed in the future that will occupy the positions in this respect once held by our old-time favorites.

Smith's Cider is a very popular winter apple in Pennsylvania and southern New Jersey. The apple is of fair size; the trees bear young, and when grown are immensely productive. The fruit is of fine quality and keeps well. It promises to do well in this section of the State.

One of the best winter apples I am acquainted with is Peck's Pleasant. High-flavored, productive, and a good keeper, it very well fills the place once occupied by the famous Newtown Pippin, a variety long since superseded by others better adapted to our locality.

Northern Spy is also a fine, high-flavored winter apple, but the tree is rather tardy in bearing, and the fruit is very liable to grow imperfect, and rots to such an extent as to impair its value.

Fallawater is a large apple, a young and abundant bearer; very popular in some portions of Pennsylvania, but of late I hear complaints that the trees fail early. The fruit is not of first-rate quality.

Ben Davis, a popular apple in the West, gives good promise here of early productiveness. The fruit is fair, handsome, of good size, and keeps well, but the quality of the fruit is far below that of the varieties already named.

Winesap, a beautiful red apple, of excellent quality, of medium size, has proved one of the best keepers.

Yellow Bellflower is also a fine-looking and good-keeping winter sort. It seems among winter apples what the Orange is among autumn ones, the chief objection to it being its large core.

Wagener stands near the head of all the winter apples I am acquainted with for quality; of medium size, with a tender, crisp, fine-grained flesh.

In southern New Jersey the Roman Stem is a great favorite, an apple the farmers always keep for their own use. At the Mount Holly Fair two years ago there were about fifty plates of this apple on exhibition, entered for the prize offered for the best plate, which shows how extensively it is grown there. I am not aware of its trial in this section.

For a sweet winter apple which is wanted for baking, Talman Sweet is probably as good as any; but the winter sweet apple of this region is the old-time Canfield, the standard winter apple of our fathers and grandfathers, a very prolific sort, and one that will stand more rough handling than any other. A bruise on the Canfield will dry up; on any other it will rot. This apple still holds its place in the affections of the farmer, though it is a poor apple for dessert or cooking. Its great merit is for cider. Its old-time consort, the Harrison, once so popular, and the richest of all apples, has failed so completely of late years that a tree of it is a great rarity. Its present status affords a fit answer to the question. Do varieties run out or degenerate? These two apples were the foundation in years gone by of New Jersey's well-earned reputation for "Newark cider," vast quantities of these apples being crushed together and distributed widely through the Newark market. There was a cider mill on every third or fourth farm, but nearly all of them long ago fell into decay.

I have only given the names of leading apples of established character and reputation. But besides these, and other less prominent ones, it is well to remember that every section has local varieties of real merit, especially adapted to their soils, and quite as profitable, if not of such fine quality, as any of the newer sorts. Many a good apple has not been honored with book registry nor described by an official pomologist. These old and valuable varieties should not be neglected and allowed to disappear. Every man who owns an orchard or an apple tree should know how to graft and bud, and see that these choice old-time varieties are not forever lost. The old Pompey, or Victuals-and-Drink apple, was a great favorite here years ago, and would be as welcome to-day as ever, but I do not know of a tree in existence in this neighborhood, and it is doubtful if it could be had in any nursery. Other varieties are disappearing in the same way, and the loss seems all the more annoying when it is easy with a few buds or grafts from one of these old trees to put a new head on a young tree and preserve the old friends.

E. Williams.

CULTIVATION AND PREPARATION OF PRUNES IN FRANCE.

According to Theophrastus, the prune was cultivated in Asia Minor in most remote ages. Pliny speaks of its cultivation by the Romans, and makes mention of eleven varieties proceeding from the domestic prune introduced into Italy by Caton the ancient. It grew without cultivation in the environs of Damascus, and a very rustic and vigorous variety, known as the black Damascus, is much used by nurserymen as subject for grafting all other varieties. Its introduction into France is attributed to the Crusaders. If tradition is exact, this valuable fruit was first cultivated in the southwest of France by the inmates of a convent near Clairac. In traveling from Aiguillon to Fumel, through the productive valley of the Lot, one sees fertile plains bordering the picturesque river sides, covered with plum trees, which furnish the famous prunes d'Ente and Robe-Sergent, which are exported to the remotest corner of the commercial world. This valuable tree, which loves a temperate climate, does not confine itself to this special section of France, but is profitably cultivated wherever climatic and soil conditions are favorable to its growth, as is demonstrated by its extensive cultivation in the valley of the Loire, the departments of the Garonne, Dordogne, Tarn, and Aveyron. The well known brand, called Tours' prunes, comes from the orchards of the Loire. Lorraine produces a variety called Quetsche, one of the best prunes for ordinary preserves.

CULTIVATION OF THE TREE.

The prune tree thrives best in clayey calcareous soil, and does not exact for its roots a loam of profound depth. Land adapted to the culture of the vine is also partial to this tree. In many localities these two valuable products are cultivated in conjunction, as the broad leaf of the vine is especially useful in protecting the roots of the tree from the intense heat of summer. Land thus planted, and valued at 2,500 francs the hectare (2½ acres), would be worth but 2,000 francs if planted in vines alone.

Arboriculturists recommend that, to obtain successful production, the prune tree should be grafted. This practice insures a faithful reproduction of the species guaranteed. The usual custom in this country in beginning or renewing an orchard is to buy the young trees from nurseries ready for transplanting, and immediately put them into the ground.

GATHERING AND PREPARATION.

When the prune is ripe, it is covered with a sort of glaucous powder called flower, which greatly adds to its value as a table fruit. As the gathering is an important factor in the subsequent value of the prune, great care and good management are indispensable. The fruit is usually gathered after the heat of the day has dissipated the humidity of the night. When possible, straw is carefully spread beneath the trees to prevent the fruit coming in contact with the earth. The prevailing custom, however, is to harrow the ground before gathering the plums. Only such fruit as readily falls when the tree is slightly shaken is gathered. As soon as harvested the fruit is taken to a building, properly called the fruitery, where it remains for a few days to complete maturity. Prunes are subjected to not less than three, and often to four, distinct cookings before being pronounced ready for market. Each of these operations has a special end, in sight of which great care is demanded. The first two preliminary cookings have for object evaporation of water contained in the fruit and preparation for the final cooking, which dries the fruit and imparts a certain brilliancy much sought after by buyers. Sun-dried prunes are most delicious in taste, but the exigencies of the trade do not permit of such long preparation. In several districts of France most primitive means are practiced in curing the fruit for market. In Provence the freshly gathered fruit is plunged into pots of boiling water, where it remains until the water again arrives at boiling point. It is then removed from the boilers, placed in baskets, and gently shaken until cool, when it is put upon long trays and exposed to the heat of the sun to complete desiccation. At Digne the prunes are not gathered until completely matured. Women peel the fruit with their nails to avoid injury to the soft pulp. The fruit is strung upon small twigs, and in such fashion as not to touch. These sticks of prunes are stuck into straw frames, which are suspended in the sun until the prunes easily detach from the stick, the pit is then removed, the fruit placed upon trays, exposed to the sun, and when thoroughly desiccated packed for market.

In the departments of Indes-et-Loire and Lot-et-Garonne immense ovens purposely constructed for prune cooking are used, but the proprietor often suffers loss from want of more commodious cooking apparatus, especially in windy or stormy weather, when the fruit falls in an embarrassing abundance, and he finds him-

self without means of immediately curing or preserving it. Most prunes are subjected to a preliminary washing to free them from dust or sand that may have adhered to them in falling to the ground. After washing, the fruit is exposed to the sun or air on beds of straw, or the trays upon which it is to be cooked, to rid it of all humidity. When dry, it is spread in a single layer on the tray and at once submitted to the oven. The trays used in rural districts are quaint affairs, varying in form, dimensions, and construction, according to locality. They are made during the winter months by peasants, are clumsy and cumbersome, and the only excuse for their use is that the peasant cannot afford to buy, and is not skillful enough to make, better ones. They are very primitive in their construction, consisting of a frame made of hoop, to which is fastened a wicker-like bottom fashioned from rushes or willow twigs. They hold from 12 to 18 pounds of green fruit, representing about 4 or 6 pounds of prunes. Care is exercised in preparing the oven for the first cooking that the degree of heat shall not exceed 50 degrees Centigrade, and in the second not over 70 degrees. If the heat is too strong, an ebullition is produced in the fruit, the skin bursts, the juice discharges, the prune becomes sticky, loses its flavor, and consequently its commercial value. After each cooking, which occupies about six hours, the fruit is removed from the oven and exposed to the air. When the prunes are cold, they are carefully turned by women specially charged with this duty. They avoid disturbing the fruit while it is warm, as the touch renders it glutinous and prevents the juice from congealing. The third cooking is performed at a temperature of 80 to 90 degrees, and occasionally at 100 degrees. This, like the two preceding, should be conducted under most intelligent care. After the third cooking the prunes are sorted, and such as are found imperfectly cooked are again submitted to the oven. The degree of perfection in cooking is obtained when the fruit presents a dark purple color, solid and brilliant surface, malleable and elastic to the touch, and when the kernel is well done and intact in the shell. When these conditions are not obtained, the kernel ferments and alters the entire prune, which very soon moulds and becomes worthless. Each cooking should not consume more than six hours. In the last, however, the process is sometimes prolonged, depending upon the condition of the fruit. The fruit loses about 70 per cent. of its original weight. The dark color depends largely upon the degree of maturity at time of gathering. The brilliancy of surface has no other commercial value than proving the cleanliness observed in preparation and attracting the attention of buyers. Besides the different usages of the prune as an aliment, it is also employed in producing an agreeable brandy.

CLASSIFICATION.

Prunes are divided into ten categories, taking the number of prunes necessary to a pound as a basis, and were formerly classified as follows: 1, trash or refuse, more than 125 to the pound; 2, small prunes, 120 to 125 to the pound; 3, small ordinary, 110 to 115 to the pound; 4, fine ordinary, 100 to 105 to the pound; 5, superior ordinary, second, 90 to 95 to the pound; 6, superior ordinary, for exportation, or half choice in France, 80 to 85 to the pound; 7, first choice, 70 to 75 to the pound; 8, extra choice, 60 to 65 to the pound; 9, imperial, 50 to 55 to the pound; 10, imperial flower, 40 to 45 to the pound.

This classification offered opportunities to sell inferior prunes for those of good quality, and to prevent this abuse was changed and simplified as follows: No. 1 represents 90 to 92 to the pound, No. 2 represents 80 to 82 to the pound, No. 3 represents 70 to 72 to the pound, No. 4 represents 60 to 62 to the pound, No. 5 represents 55 to 56 to the pound, No. 6 represents 44 to 45 to the pound, No. 7 represents 40 to 41 to the pound, No. 8 represents 34 to 35 to the pound, No. 9 represents 30 to 31 to the pound.

EXPORTATION.

When ready for exportation, the fruit is pressed flat between two cylinders covered with rubber, and then packed into cases by a special machine called a packer. Many dealers still perform this operation in the primitive manner of foot pressure, which is simple, speedy, and equally as satisfactory. Bordeaux is the principal center of this particular commerce, which is yearly increasing. Besides the large amount of prunes exported to European countries by way of rail, there are about one hundred vessels annually leaving this port loaded with this valuable and succulent product. The most important exportation of this production is to the United States. During the past eight years $4,553,000 worth of prunes, or an annual average of $569,125, have been invoiced through this consulate, as will be seen by the following:

Years.	Value.
1880	$219,736 68
1881	525,052 58
1882	369,150 64
1883	661,166 69
1884	577,480 58
1885	792,640 96
1886	840,299 19
1887	568,356 82
Total	$4,553,884 14

OVENS.

In the beginning of the prune industry many devices were employed for their proper conservation. The first ovens were very primitive, and the work of preparing the fruit for market laborious. At present there are many different kinds of ovens in use, possessing more or less distinct features, but about the same in general principles. The most generally used are the "Bournel" and the "Marletean" ovens. The only ovens in use are of French patent and make.

GEO. W. ROOSEVELT, U. S. Consul.

Bordeaux, September 5, 1888.

MATCH-MAKING calls for the best Pine plank, as free from knots as possible. They are cut into blocks 11 in. long, 4½ wide and 3 thick. Each maker has a recipe of his own for the phosphorus paste in which the ends are dipped.

COTTON AS A FILTER.

By A. B. CLEMENCE.

IN the estimation of silicon in pig irons, a large portion of the time is taken in filtering off the silicon and graphite, especially in irons rich in silicon. If a filter pump is not at hand, and a filter paper only is used, three hours are often taken for filtering and washing a solution that contains 3 or 3·5 per cent. of silicon, and even when a pump is used, in which case a support must be used, the filtering is often tedious.

Having had occasion some time since to estimate the silicon in a large number of samples of iron rich in silicon, I looked for a quick filtering material, and in cotton I believe I have found all that could be desired.

The method of analysis is the "sulphuric acid method," with, perhaps, some slight modifications.

One gramme of the borings is placed in a 6' evaporating dish, and 40 c. c. of a mixture of one part concentrated sulphuric acid and five parts nitric acid of 1·20 sp. gr. are added. A watch glass is placed on the dish and set on an iron plate heated by a 6 inch multiple burner.

The dish may be left without care until the iron is dissolved and evaporated till the ferric sulphate has spattered on to the watch glass. Water is now added and boiled for two or three minutes, when it is ready to filter.

The filter is made as follows: A 3 inch filter paper is folded as usual and the apex cut off, leaving a hole about ½ inch in diameter; a wad of cotton (the absorbent cotton of the druggists) is pressed into the apex, and, when wet, may be, either with a pump or by the mouth, pressed tight enough to hold the residue. Even without a pump this filter will run so fast that close watching will be needed to keep the funnel full.

Wash as usual with hot dilute hydrochloric acid and with hot water, when the residue, cotton and paper, is ready for the weighed crucible. Burning with a blast lamp completes an estimation in forty minutes from the time of weighing the borings. The weight of the ash of the cotton will of course vary with the amount used, while that of the paper will be the same in each case, but it never need be more than 0·0005 gramme, and this small amount may be disregarded when working on silicons for Bessemer charging.—*Journal of Analytical Chemistry.*

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